BRICKMAKERS MANUAL.

By R.B. Morrison
And J.A. Reep . . . .

Brickmakers' Manual

—BY—

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Compiled and Arranged with Additions

—BY—

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AN ILLUSTRATED HAND-BOOK FOR READY REFERENCE.

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PREFACE.

Brickmaking, although one of the oldest industries of which we have record, and one of the most useful to man, was carried on for thirty centuries or more, using the same method adopted by the sons of Noah when they established their famous "plant" on the plains of Shinar soon after the historic flood. There was held the first brickmakers' convention and the resolutions there adopted are still in force among their followers, for they said one to another, "Go to, let us make brick and burn them thoroughly."

During the last half of the present century, however, this great industry has improved wonderfully on the primitive methods of Noah's sons. Steam power has well nigh revolutionized the business and the brickmaker of twenty-five years ago who has not kept abreast of the spirit of improvement, must again become an apprentice and learn his trade a second time or retire from the field.

Until within the last twenty years our craft was without clay literature, there being no practical works in print on the subject of brickmaking. The writer began a series of articles on brickmaking which have appeared monthly in the columns of the *Clay-Worker* during the past five years. These articles were intended to help those who engaged in the manufacture of bricks without practical knowledge of the business, rather than men in the business who possess practical experience, and this little volume is given to the craft as a book of practical hints, based on years of experience and careful observation in the manufacture of

brick. The writer makes no claim to a scientific treatise of the subject. If the writing of this book will help some of our brick-making friends to make a better brick than they did before and with increased profits to them, the author will feel amply rewarded for his effort.

R. B. MORRISON.

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Brickmakers' Manual.

CHAPTER I.

INTRODUCTION.

In sending out a book to find readers it is important that it be one that is instructive, or highly entertaining. There are many reasons for this. The principal reason is that books are so plenty and have become so cheap, that there are many good books begging for readers. Every field seems to be fully occupied in the domain of literature.

Let us glance over it and see: History is a fertile, and at this day, a very productive field. History is being enacted every day, and all about us. The times are fraught with great events, and we do not lack historians. Scientific workers and writers are busy, and their name is legion in every branch of art, in mechanics, in agriculture, the scientist has been there with the alembic, the crucible and retort, and where the scientist has not been in pursuit of knowledge "no man knoweth." Some of them have even peered into the glowing arches of the brick kiln; and in the scientific journals we read of the evolution of heat from combustion and its close relation to electricity; units of heat, the fluxing of molecular coatings, the vitrification of clays, etc., etc., which all goes to prove that progress has been made and greater results will follow. The poet has told his tale in verse, and we lack nothing in that line. And what a field of brambles and weeds is fiction!

Look, now, at the field of Art and let us see what has been done for the brickmaker, as the making and burning of bricks is among the oldest of arts and in this particular branch of art there has been less written than any other. Books on brickmaking are scarce on the shelves of our libraries. There are few, indeed, who are engaged in the brickmaking business who have even a single volume to direct them, and nothing at all in most cases, except the circulars and catalogues of advertisers who have machinery to sell, and these describe the process and management each with his own particular machine, in a very brief way, and are usually very limited as to the process of making and drying; and burning is something with which they are usually not acquainted.

We do not desire to be understood as saying there are no books on brickmaking. We have read some works on that line, but our experience is that they usually are so high priced that but few will buy, not from inability, but from force of habit. We think, after looking over the field, that the times are ripe for a book on brickmaking—one for the average brickmaker, the man of small means, as well as his more wealthy competitor; for the brickmaker whose output is half a million, as well as he who makes thirty or fifty millions annually. We will endeavor, in these few pages to give you the best we have, leaving out all the vague and mysterious terms of the scientist, of which the average brickmaker knows practically nothing, and tell you in as few words as possible what we have learned about bricks and their manufacture. We propose to give short chapters on each part of the process and so classify the work as to make it a ready work of reference. Also to use such terms as are common among the workmen, so that it will be more readily understood, and a book that will be inquired for by foremen and managers of yards, as well as proprietors.

While we do not ignore the scientist and his terms, we think

the bulk of the men who are engaged in brickmaking, are not versed in science and know nothing about chemical or scientific terms in relation to the brick business, but feel that they have skill enough to both make and burn good brick if some one will but show them the way, or tell them how it can be done. Many of them have seen or heard of a better and more profitable way than they are pursuing, but they reason in this way: "I have seen a great many experiments tried in brickmaking, particularly in the way to burn, and I have tried some myself; and, after all is said and done, I have settled down to the way I am doing, and I am hard to move out of that way. The risk is so great, as I have seen so many failures in making, drying and burning, and all other parts of the trade that I can't afford to try any new experiments."

We will not go back and dig up the ruins of Babylon to get bricks and mosaics, and speculate as to their manufacture. We will leave that for the antiquarian and confine ourselves pretty closely to the present and its advantages over the methods of fifty years ago. We will endeavor to aid the progressive brickmaker, counsel and advise the old style manager, and adopt all the labor-saving and money-making methods that we can find to help you on in your business. We think it would hardly be consistent in us to write an article in this work and go into all the details about how to make and burn a kiln of brick on the old style plan of fifty years ago, when every city, village and hamlet in the whole length and breadth of the land has from one to one thousand men in it who consider themselves adepts in that style of brickmaking. We propose now to learn something from those who criticize this work; and give our readers our "Hints on Brickmaking" as it should be, and is done, in the most economic and expeditious manner, and what few readers we do have, we hope to merit their approbation for our weak efforts in their behalf.

CHAPTER II.

HINTS ON STARTING A BRICK YARD.

The first thing to be considered in starting a brick yard, is a market for the product, for upon this depends your financial success. I have many times during my travels come across a site where the ground was well adapted to the business; laid high and dry, level, easy of access; an abundance of good clay, water convenient, and all that could be desired except a market for the wares. And under the head of market, must be considered facility to the market; how the yard is located so as to be easy of access to wagons, cars, or boats; how I can in the cheapest and most expeditious way, put my brick on the market. If you have a choice of more than one bed of clay that is good, then choose the best location with regard to drainage, water supply, and facilities for shipping, and getting fuel to the works, also. In regard to drainage, get above high water mark, if possible. Many a brickmaker has lost all by floods. Have one or more main drains of sufficient size; then have lateral drains connecting with these leading from engine house, machines, dryers and kilns. On most all yards there is waste water at the machines, clay pit and tank.

The clay bank should always be drained with a large ditch if possible; if that is not practicable, water must be lifted out with machinery of some kind.

Drains about the works must necessarily be covered, and the end of the drain where the water enters should be protected with

a screen of coarse wire, or small iron rods three-fourths of an inch apart. In dry weather these drains should be closed with a board or piece of sheet-iron to prevent them from getting clogged with rubbish.

Secure for the drain as much fall as possible and avoid all sharp angles. These drains will always be a source of satisfaction to the proprietor, as well as the employes, saving the former many dollars and the latter many a ducking.

The next important adjunct to any brick works is a good foreman, one who thoroughly understands his business, and is a practical workman. He should have some considerable business knowledge, and tact enough to be able to keep every employe about the works in complete training, seeing that each man performs his allotted task, with skill and dispatch; and his habits should be such as to command the respect and confidence of both employer and employe.

The next thing is a full supply of good tools; enough to carry on the work of brickmaking without hitch or jar, for lack of anything in the line of tools. And this includes a dozen picks, two mattocks, two dozen shovels, four spades, two dozen dirt barrows, two dozen brick barrows, three large size iron ash barrows, two crowbars, two pinch bars, fifty feet of three-quarter inch rope, one hundred and fifty feet of one-inch rope, with pulley blocks, two jackscrews—one long and one short one, two axes, two hand axes, with hammers, hatchets, saws, square, brace and bits, a dozen assorted files, wrenches, cold-chisels, punches, etc., etc., together with an assortment of nails, screws, bolts, nuts, washers, etc. I think where the yard is established with a proposed capacity of fifty thousand per day, it is a very good plan to secure a man as engineer who is a good mechanic, and can work at the forge and do the blacksmith work for the yard repairs, etc. Let him have an assistant as fireman, who keeps an eye on the engine during his

absence and then the engineer can do any work that he is called upon and yet be near all the machinery. Let him be provided with a forge and anvil, a bench drill, a set of dies and taps up to one inch and provided with a small stock of iron rods and bars, and a few pounds of bar steel. And if he is skillful he can save many large bills of repairs, and machine shop work. And I have seen works where the engineer was provided with a set of pipe fitting tools, and then he could attend to all steam and water connections, saving many dollars to his employer. Such a man as engineer always commands higher wages than a man who can turn on and shut off steam, but an engineer such as described is cheaper at one hundred dollars per month than some we have met would be at one dollar per day.

In furnishing a brick plant with a complete outfit in the way of engine, boiler, machine, puggers, disintegrators, crushers, elevators, hoisting apparatus, and a good system of handling and drying brick ready for the kilns, together with kilns and driers, there should be great care and attention given the matter before hand. Do not under any circumstances buy old machinery, unless you are well acquainted with it, and its capacity for work, or you may find when it is too late, that it would not suit the former owner for the same reason that it does not suit you.

Be sure your engine has more power than you need. If you have an engine and boiler of large power you can run your machinery with less fuel and lower head of steam than a small power with double the pressure, and you are also in shape to add to your capacity at any time without stopping the works to haul out the small engine and replace it with a larger one.

See that everything needful is procured before starting the works, everything in its place and kept there, all machinery well located in line, plumb and level. Do not start up in a half-handed way, with a quart of oil, when you know you are going to need it

by the barrel, nor a wagon load of coal when you are going to run steady for a month and will use several carloads.

It is always best to spend some time in visiting some of the best brick plants in the cities adjoining you, or even at a distance, where there is a variety of machines, dryers and kilns in operation; determine on the kind which is best adapted to your clay and your means, then purchase what you need, not what you think you need. Your wants will become known to you as you grow in the business. Do not make any one yard a model for yours, but select the best you can find on a dozen or more and combine these to perfect your plan.

If your clay is best adapted to soft mud brick and the market is against stiff mud, you can select among the soft mud machines and puggers, that which you consider to be the most economic, taking all things into consideration.

You may have to pay a higher price for the machine you want, and, in this way, save a continual expense in labor, repairs and stoppages, which are expensive.

It is a good plan to attend the State Fairs and Industrial Exhibits, to see the clay working machinery in operation, and compare the work with your clay and its adaptability to the machine in question. If your clay is of a variety that can be worked direct from the bank, in a semi-dry or stiff-mud machine, then I would not attempt the business with a soft-mud machine. Our preference is for the stiff mud machine for the reason that the brick can be handled direct from the machine and hacked from six to ten courses high; this cannot be done with soft-mud bricks, as they have to be laid on their flat sides on board pallets or drying floors, occupying much more space. The stiff-mud brick contain less moisture, and are quicker and easier dried.

The dry clay process of brickmaking is just now receiving a

great deal of attention, and is deserving of something more than a passing notice. The dry clay yards, so far, have, as a rule, been failures, and a great deal has been said and written on the subject. But out of these failures, success will in due time come. As yet the system is largely experimental; in some places, with suitable clay, and after long, laborious and continued effort, there has been a measurable degree of success. While we have no need to decry the method, we think that the dry clay process of brick-making is not well adapted to small yards, for several reasons which we will name: First, on account of the greater cost of buildings, machinery, kilns, etc. While it is supposed to do away with the trouble and cost of dryers, yet, where we have been on yards that were meeting with a measurable degree of success with dry clay machinery, they employed their exhaust steam to further dry the brick, before entering the kiln. We believe this is a good plan, as the dryer you can make the brick, the less time is consumed in burning. We have found by experience that the most expensive place to dry brick is in the kiln, after they are set ready for burning. Another reason is, the process is more modern, and I have seen where some writers urge it upon those who contemplate starting a dry press yard, to secure the services of a man who has been successful in managing such a yard; this is a very good piece of advice, but hard to do, as the admission made by the writer, previously, would lead one to believe that there was more failures by far than successes. Where, then, would we look for such help as is desirable? They are employed already *if* successful, and, if they were transferred to another locality in different clay, their success might be turned to defeat, and they in turn left stranded. If the process was adapted to the successful making of brick under all conditions, there might be some hopes for it coming into universal use.

But no one process will ever be universally adopted.

There is another argument against the dry clay brick and the stiff-mud brick also, to a certain degree, and that is, they are more dense and compact, and, consequently, harder to burn.

These are the chief features now against the method. Let us see what can be said in favor of the dry press:

First, the cheapness of handling the brick from machine to kiln direct.

Second, no expense of building and operating dry houses or dryers.

Third, no loss by exposure to weather.

As the supposition is, that the clay is to be worked dry enough, so frost will have no destroying effect on them, we will add also to these another opinion, which is based on our observation: That the cost of drying the clay, re-handling and preparing it, is so much greater than the drying of green brick by any method with which we are acquainted, that we would hesitate to advise anyone to enter the field while there was a surer method of success. I cannot see why it costs less to dry a brick before it is molded than afterward.

As to the quality of the bricks made on the three different machines, there is a great difference. The soft-mud machine and hand-molded brick are almost identical; the difference, if any, in favor of the machine made brick. The stiff-mud brick are all more or less imperfect, and generally, are not adapted to outside walls or fine fronts without repressing, but for all inside work, are just as good as any brick made; while the soft-mud brick are better finished and have well defined angles, and the sand coating gives them a smooth surface. The stiff-mud brick are stronger because they are more dense, crack less in burning, making less waste in the arches and also in handling. Each have their advantages and disadvantages, and can be learned, which is desired for a local market, by interviews with the contractors and brick

masons in your neighborhood. The kind of clay to be used should have much to do with the choice of machine. A sandy or short grained clay will work best on a soft-mud machine, while a plastic, unctuous clay will do best on a stiff-mud machine and will not require tempering wheels or pugger. When a stiff clay machine is used and clay is hard to dissolve, a crusher or disintegrator is necessary. Where either of these are used, the clay can be carried to them, also from them to machine by elevators, of which there are many kinds.

CHAPTER III.

THE CLAY BANK.

The first and most important item in brick manufacture is the clay bank. In the preceding chapter we spoke of this and wish in this chapter to further impress it on the minds of those who contemplate starting brick works on an extensive scale.

We have seen many rich firms and corporations, who had carried on the brick trade successfully—for a few years—and had shaped their works from the start to make bricks from clay banks contiguous to the works. These same firms, after having built up a trade and a reputation for their goods that was enviable, found that their clay supply was in a fair way to give out. There may have been several reasons for this. When the works were established, this firm had probably counted on a steady output of forty thousand bricks per day, and if their trade had remained at that, as an average during the years past, they might still have had clay to run the works for several years to come. But the expansion of their trade was greater than was expected, and, from forty thousand per diem, grew, in some cases, to one hundred and forty thousand, for a day's output; and this, too, continued for many months. At this rate, their supply was limited in a few years, and they were obliged to shift about from one point to another, and tracks had to be moved, or roads changed, frequently, causing loss of time and expense, and in some cases, of which we are aware, it has been necessary to construct a small railroad,

several miles in length, to the clay beds, and a complete overhauling and change of the works to suit the changed condition in that respect. Again, there are many cases where the entire plant has been moved frequently, from one point to another. This is observable on the suburbs of nearly all our Atlantic Coast cities. The clay lies in shallow stratas, varying from two and a half feet to six feet, scarcely ever exceeding that depth. The brick plants established at these places are generally on ground that is leased a few acres at a time, and are calculated to last only long enough for the city to grow up to, and, in some cases, beyond the limits of the brick yards. This was to accommodate themselves to their trade and be near their contracts, thus saving long and expensive hauls by carts or wagons. And it was best to allow the ground occupied as brickyards to be built upon and they, in turn, pushed farther out. This is plainly the case in Baltimore and Philadelphia, while in the neighborhood of Richmond, Virginia, what is called Rocketts, or rather meant "Rocketts' Old Fields," have been brickyards since a very early day, in the history of that city. The reason why these brick yards confine themselves to this point is on account of the great depth of the clay. A manufacturer here, with a lease on three or four acres of clay bank, is safer than he would be in the neighborhood of Philadelphia with twenty acres, not counting anything in favor of either place in regard to market. And the same is true of many sections of the country. The clay can only be used for a few feet and must have the top soil incorporated with it to insure anything like a marketable product. While others again have clay beds of great depth and well situated for the establishment of permanent works, with no danger of a shortage in clay.

We will, therefore, assume that your works are located, including your clay bank, as an adjunct. And you should begin, first, by making preparations to drain the clay pit. This must be

done, or you will find yourself so overwhelmed with water during a great part of the time as to be unable to get out clay. And where a steady output is desired, your clay bank must be so arranged that clay can be taken out at nearly all times, barring floods.

There are three sources from which you may expect water to cause a hindrance in mining clay. First, that which falls on the bank as rain or snow. Second source is surface water, which will ooze in from adjacent low ground on top of the clay strata below the soil, or is forced up from the bottom through the underlying sand or gravel. Third, is from floods or overflows.

If the clay bank is on low ground, alongside a creek or river, as is usually the case, then there is no remedy; and the only way to do is to wait till the waters have gone down. In such case, it is well to have a ditch of sufficient size cut through to lower levels as an outlet for the water in the bank, and which will give you rapid and efficient drainage.

To drain the clay bank properly, it is necessary to begin mining at the lowest point and rise gradually, so that water that may fall upon it, as well as that which rises from below, will run from the bank instead of towards it.

If there is not sufficient fall for drainage, the water must be lifted out with a pump or siphon. There are many devices now in use for lifting water rapidly and cheaply, so that the matter of drainage is only of secondary importance, as clay can be mined to any depth, as well as any other mineral; however, it should receive careful attention, so as to avoid losing time for want of clay in wet weather. If the clay lies below high water, the only way to prevent loss of time during floods, is to have a sufficient stock of clay stored on higher ground to use when necessary; the increased advantages of steady production will more than compensate for the re-handling of this clay. In taking clay from the

bank, it is best to use the soil and subsoil beneath; first removing the sod or surface growth that is full of roots, or undecayed fibrous matter that would clog the machinery; this saves labor and also saves clay; and where the clay is of sufficient depth and strong enough to bear mixing the soil with it, it usually gives a richer color to the burned brick. All clays give better results when taken from top to bottom, the whole mass being mixed thoroughly, insuring uniformity of shrinkage in drying, and color in burning.

If your clay is underlaid with a strata of fine sand, part of it can be used with benefit, thus saving your clay, preventing loss from cracking of bricks in drying; rendering them easier to burn and making less strain on machinery in the manufacture. How much sand can be used, can soon be learned by experiments in that direction.

A brickmaker should visit his clay bank every day, to see that it is properly managed. Clay is liable to vary in different parts of the bank and different varieties of clay may require a different amount of settle in the burning, some more, others less, and unless this is closely watched, may cause serious loss, and no apparent reason for it. There is another thing that must be watched in the clay bank, and that is the method or manner of mining it; no matter what method is in use, picks and shovels alone, or steam shovels, there still remains two ways—a right way and a wrong way.

I have seen a force of men in the clay pit, under the management of one man who understood the work, who could mine and load clay for seventy-five or eighty thousand bricks per day, and do it with ease. Again, I have seen the same number of men without a leader or boss over them, each one doing about as he pleased, that were worked much harder to get out clay enough to make fifty thousand bricks each day; and, so far as I could see, one bank was as good as the other, all things considered.

Where your clay bank has a breast or depth of eight or more feet, and your output is fifty thousand and upwards, it is economy to use powder and blast the clay; particularly so during dry weather, when the clay bank is sun-baked and dried to a rock-like consistency.

This can be done in the following manner: Let the bank be squared down to the floor level and nearly plumb, then cut under with the picks, a channel of six or eight inches at the bottom the length of the bank which is desired to be thrown down. At the same time let another force, provided with augers, be boring holes four feet or more from the edge of the bank and down to a level of the floor; the distance from the edge can be determined by the depth of the bank; the deeper the bank the wider the slice that can be split off. It is best to have two or more augers, made with any common two-inch carpenter's auger; let one be provided with a four-foot shank, and another an eight-foot, and, if your bank is a foot or two deeper, still another. But if your clay goes on down to unusual depths, then it is better to mine it off in benches, eight or ten feet to a bench, making a level or floor at the bottom of each bench. Let the short auger bore the holes as deep as they can reach, and then finish with the long shanked auger. A hole eight feet deep can be bored in less than fifteen minutes.

A row of holes ten feet apart, scattered along the bank for one hundred feet, will embrace within its limits enough clay to make from sixty to seventy-five thousand bricks. After boring these holes, a half stick of dynamite exploded in each of them will spring the clay and make an opening in which a charge of powder can now be fired, which will throw down the whole bank and in most cases the clay will be pretty thoroughly mixed in the fall.

If the clay is in need of water, it is now in fine condition to be put in soak for use on the following day. Where everything is

properly arranged this can be done by having a two-inch pipe connected with the pump at the engine house and laid to the clay pit; and a few yards of two-inch hose at the bank to sprinkle the clay as it lies after being blasted out.

If your works are not extensive enough to warrant this outlay, and your dependence is mainly on picks and shovels, you can still, with proper care and forethought, save much expense in this part of the work. Let one man be selected who has some skill and speed combined; let it be understood that his duty is to cut the drift or channel under the bank by picking underneath as far as can be done with safety; he can attend to this while others of the force are loading the cars or carts at another point in the bank.

After the cut is made below, as far as desired, then go above, and, with the pick, strike a channel through the soft soil till you come to the subsoil below and about three feet from the edge of the bank; then let three men take each a good, strong, chisel pointed crowbar and drive down at several points along the channel, and split off in this way, almost plumb, the whole face of the bank; and in this way more clay can be loosed up in two hours' time, ready to shovel into carts, with only three men, than a dozen men can do with picks alone and work all day, as I have seen done by working from the top downwards, with no digging under as a starter.

Another important item concerning the clay bank is the quality of the clay. The quantity can be determined by having a number of holes dug to the depth of six or more feet, or bore holes with the auger as described in this chapter. The first method is the most satisfactory unless a man is skilled in the business of prospecting with the auger.

The best method of testing the quality of the clay is to make brick from it, dry them, set them in the kiln and burn them thoroughly; some should be set in the arches, some in the body

of the kiln and some near the top; there is then a reliable test made as to their shrinkage in drying and burning as well as to their strength and color; this test amounts to demonstration. A practical brickmaker can judge of the strength by its quality and appearance. Clay that is plastic in its nature and breaks into angular particles, and parts in irregular seams, indicates that it is a strong, tenacious clay, and will produce, if properly made and burned, a strong and durable brick. If it breaks up fine, with the seams smooth and straight, having the appearance of soft stone, it indicates loamy or sandy clay, less tenacious, and will make a brick inferior in strength to the other; but if well burned will endure the action of the weather and atmosphere in the wall as well as the other; but, at the same time, is more likely to become damaged in the burning, especially in the common clamp walls where they are subjected to the drafts of cold air during the burning process.

I mention this matter in connection with the location of your works, as upon it depends the success of your enterprise; that is, in regard to the color and quality of your ware. After your tests of clay have been made and you find you have not less than four feet of clay, and the deeper the better, you turn next to the requisite in any brick yard, which is water. There should be a never failing supply of water within reach; for when there is little rainfall and scarcity of water, then it is most advantageous to make brick; for they dry rapidly and without loss, and every day can be improved in making brick. The clay in a dry time requires more water than at any other time, so that when water is naturally scarcest, most is needed. I have frequently seen yards idle for want of water in the very best of weather for brickmaking, and the next season, perhaps, idle again, because they have more water than they know what to do with. So the necessity of an abundant and reliable supply of water is very important, not only

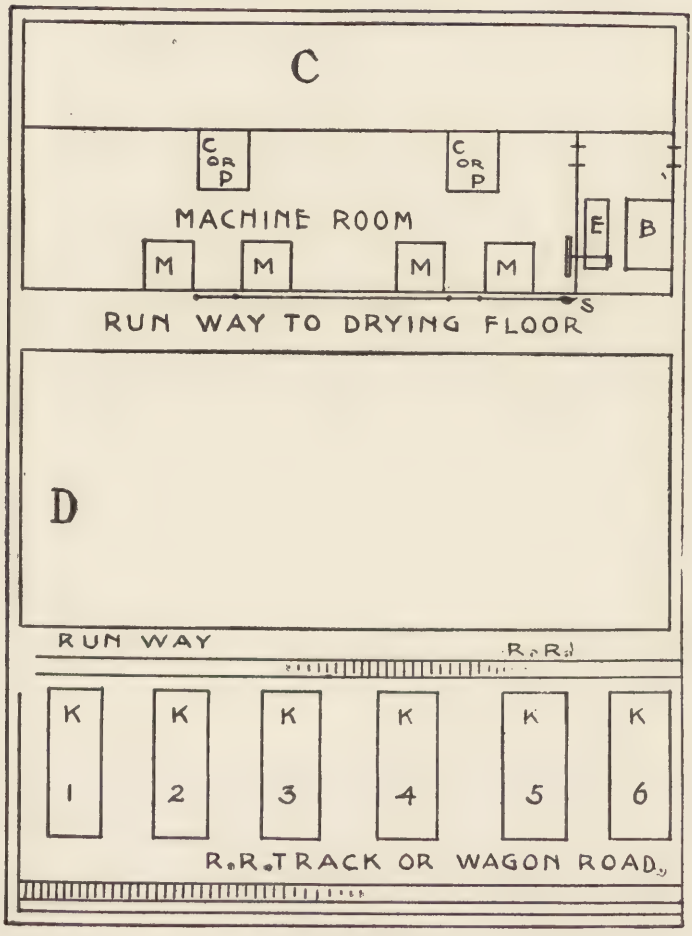
for the making of brick but a good quality of water to supply the boiler, and drinking water for the use of the hands. Then arrange a system of pipes around the works, so you can turn on a hose on short notice in case of fire; let the kilns be especially provided with this means of putting out fires.

CHAPTER IV.

PLAN OF YARD.

In laying out your yard, begin with your rail track for cars, or boat landing, and locate your kilns at a point where they will be convenient to fill and discharge. Have your drying sheds next to the kilns; then next to the dry house is the machine room with the engine and boiler conveniently located. Back of these is your clay bank. The following diagram is a general plan for brick works which has been adopted by many of the largest firms and most successful among the brick manufacturers. One advantage claimed for this plan is that the clay when it leaves the bank, moves continually forward towards the kilns, and from thence direct to cars or shipping point, and practically, the drier men are not in the way of the machine men. The dry rollers also work on the opposite side from the machine men and are out of each other's way.

In the illustration, C represents clay shed; E, engine; B, boiler; S, line shaft; M, machine; D, driers; KKK, kilns; RR, railroad tracks at each end of kiln. The fuel can be unloaded at kilns or driers from the same tracks. The track at opposite end of kilns is used for bringing fuel to kilns, and also for shipping brick by cars. The engine, boiler and machines are out of the way of smoke and dust from burning and discharging kilns; and if the kiln sheds should take fire, the engine house and machine sheds are comparatively safe. This arrangement of the works will be


C
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RUN WAY TO DRYING FLOOR
D
RUN WAY
R.R.
K 1
K 2
K 3
K 4
K 5
K 6
R.R. TRACK OR WAGON ROAD.

PLAN OF YARD.

found very convenient where it is at all practical to so construct them. Where artificial dryers are used, and wood or coal is used for heating them, the furnaces of the dryers should be placed next to the kilns, and the smoke stack next to the machine. Where there are tracks at both ends of the kilns, it is best to have the track between the kiln and drier elevated from four to seven feet, according to location and a good road graded beneath it to allow for cars, or truck and barrows, to pass underneath with green brick to the kiln without being delayed by loading or unloading cars standing on track. The only disadvantage this offers, is the inconvenience in loading cars that stand on the elevated track. Where barrows are used in loading cars, the top half of kiln can be loaded on the elevated track, and the arches on ground track at opposite end. One advantage this raised track has over a ground track is it allows a large space below the track as storage for fuel, and saves a great deal of re-handling to keep the track clear.

In placing brick machines in position they should all stand in line, and all be driven from one line of shafting. This is a saving of space; makes the work all run uniform when changes are made from one machine to another and the driving belts are all of uniform length, and the clear space underneath is all alike. The line shaft should stand on trestles, independent of the frame work of the building and about twelve feet above the floor of the machine room. This will allow of the driving belts being carried well up out of the way of the workmen. Of course, this will depend somewhat on the kind of machine used. In some cases this plan would not be best, but for all upright machines that are built for a top feed, it is an excellent plan. The clay should be brought in on an elevated track from twelve to twenty feet in height, and arranged so that it will move downward, into, and through the intermediate machinery and pass from

there into the brick machine without much labor in shoveling, or the vexation of elevators.

Arranged as stated above, one man can feed each machine for twenty-five or thirty thousand brick per day. If not so arranged, and the machines have to be fed with shovels, it will require two, three and sometimes four, men to keep the machine supplied when the clay is dumped on the ground, level with the bottom of the machine. It is taken for granted that any man putting up a new plant on improved plans will want to provide for the use of clayworking machinery of some kind. Inclined tram track, with hoisting machinery, drums and cables, are being put in in almost all new plants where it is at all practicable to do so, as well as improved machines for preparing the clay, separators, crushers, etc. The engine house and boiler should be separated from the machine room so as to avoid the dust and keep the engine clean, as it is well known that dust will cause an engine to wear out faster at all of its wearing parts; and it is the best economy to make this effort to save your engine.

If artificial dryers are used, the bricks should be handled from the machine to the kiln on cars; this saves fuel and labor, and prevents damage to the bricks in handling. If soft mud brick are made, it is necessary to use hacking pallets of wood or iron in order to dry them on cars. An iron pallet is best, but the cost is much heavier than wood and prevents their general use. If some inventor will make an iron pallet that can be had for the price of from ten to fifteen or twenty cents, he will do well with it, as it is much needed. Wood pallets cost from 5 to 8 cents each, according to the cost of lumber. We think it is a great mistake to make pallets of plastering lath, as is frequently done. They are too frail and short-lived; they will not stand the rough usage incident to a brickyard, and neither will they keep their shape when subjected to the heat of a dryer on one side and the moisture of green brick

on the other. It is money thrown away to use this kind of material for pallets. The laths or strips for pallets should be not less than $\frac{5}{8}$ or $\frac{3}{4}$ of an inch in thickness, and $2\frac{1}{2}$ inches wide. These will bear a man's weight without breaking, and this is necessary, as they very frequently have it to do when in use.

It is usually cheapest to order the lath sawed at the mill the size desired; three feet is about the usual length, and if they are ordered this length they can be sawed from material too short to be marketed and can generally be gotten cheaper on that account, as a great deal of unmarketable material can be utilized for that purpose. The experience of the writer is that the round finishing nail or wire nail is best to use in putting them together, as they will not split the end piece, and holds well in the wood. When stiff clay brick are made, it is not necessary to use pallets to dry them in tunnel dryers, as they can be hacked or piled up in loose hacks on the cars. Many brickmakers prefer to use pallets with stiff mud bricks as it saves them from being damaged by contact with each other, as when they are hacked on the cars. A pallet made of two pieces $\frac{7}{8}$ of an inch in thickness, four inches wide, nailed one and a-half inches apart, to end pieces 2x5 and ten inches long, answers very well for this kind of bricks. Where stiff mud bricks are hacked on cars for drying, they can be placed on an open frame of wood or iron and six or eight courses deep, the bricks spaced from one to one and a-half inches apart, reversing each tier, and in this way they can be handled and dried and moved to kilns ready to set without pallets, and but very little damaged. This mode will answer for common building bricks, but for fine front or ornamental, or moulded designs, pallets are necessary.

At many yards, after the bricks are made they are carried to the drying yards or sheds in an opposite direction from the kilns, instead of toward them. It is plain that this is labor lost. Let every move take them nearer their final destination—the loading point

—cars, boats or wagons. It seems to me that when parties contemplate starting a new brick plant, or enlarging an old one, or remodeling one to a yard of more modern design, it would pay them to secure the services of a competent and experienced man to make a plan of their works with two objects in view: First, let it be so arranged that the clay and moulded bricks always move towards the kilns, with as few handlings, and short journeys as possible. Second, if you begin your works with only one machine, have it so constructed that you can increase to two or three, or even a four, machine plant without remodeling the works or re-arranging the original plan. If men without practical experience in the brick business would do this, it would save them many dollars, as well as many disappointments and vexations of spirit, and the telling to their friends in after years of how it ought to have been done in the start, and how they would do if they were to begin again and put up another plant. This is all unnecessary.

Enough has been done to teach experienced brick men how brick works should be built. One trouble with many men who have no experience in the business is, they think they know better how to do all these things than the men who have grown gray in the business and have kept up with the foremost. If you mention that such a plan or method has been tried and abandoned as a failure, you will hear a whole volume of theory that is going to carry these enthusiasts on to fortune; no danger of them stranding on that rock; they will steer away from it; they propose to turn everything right around in the brick business. And they usually do, and run the boat ashore in a hurry; buy their knowledge and pay a good round sum for it. A false economy in this line leads to serious loss, and a distaste for the business is sure to follow.

There are a great many men engaging in the brick business

at this time who are not practical brickmakers, and in many instances I have known, they have generally managed to waste a few thousand dollars in needless expenditure because of their lack of necessary knowledge of the business. There have been brick plants put up in the past few months that cost the owners forty thousand dollars, that should have cost but twenty-five thousand. Now, why was it? First, they began without a complete and definite plan. Second, the plant was constructed without a practical, competent brickmaker to superintend and manage the works. The question arises here—can a brick works be planned, constructed and equipped so that it is successful and profitable from the beginning? Or, must there be a waste of time and money caused by mistake and poor management in building the works and one, two or three years of unprofitable brickmaking? If the latter case be true, then brick manufacturers are to be pitied, and the art of brickmaking sadly in need of skillful men of the craft to push it to the front with its sister industries—a place where its great importance demands it should be. If a blast furnace, which is more complicated in every way, can be properly built and made to pour forth its molten stream as abundantly and profitably the first year as it does the second or third, why cannot a brick plant be made to do equally as well?

Years of experience and observation, as well as a kind of professional pride in your place, which lurks in the breast of every thoroughbred brickmaker, compel me to believe that a brick works can be properly planned and economically built and equipped, and made from the beginning, successful and profitable. There are men in this country capable of planning brick works as they should be, and hundreds of intelligent and practical men to execute them properly and manage them successfully and profitably to the owners after they are built. It is not necessary, then, to make these mistakes and incur these losses. When men realize

that brickmaking is not only a trade, but an art, requiring years of experience and intelligent thought to acquire a requisite knowledge of the business and then a close application of the same to the manufacture of their wares, they will not attempt to manufacture bricks with incompetent help, but will at once secure a man of indisputable capability, and not until this course is adopted will this immense waste of capital and business energy be avoided.

This is written more particularly for the benefit of those who contemplate going into the business, than for those who are already in, for it is not every man who sayeth, "Lo, I am an expert brickmaker," that will prove to be such a one.

A friend wrote me once that he had secured the services of a man to superintend his works, who came from a distant part of the country where experts are supposed to flourish in abundance. This man found fault with everything about the works and held supreme contempt for the ways of all the native brickmakers and said he: "Behold, I will burn a kiln of bricks the like of which was never seen in this forsaken country!" "And," adds my friend, "he succeeded beyond my expectations in carying out his boast, for," said he, "there was not a single hard brick in the whole kiln." This is a true incident and is a fair sample of what has happened many times before and will continue to occur until brick manufacturers employ only those who are known to be proficient and trustworthy.

CHAPTER V.

PLAN OF BRICK WORKS FOR STEADY OUTPUT.

One very important object in starting any kind of factory is a steady output.

After a number of years' experience, it is the opinion of the writer, that the two great points in the business of brickmaking, are: First, turn out the full capacity of your machinery every day. Second, get this product into the market with the least possible waste after the bricks leave the machine. The waste in drying, burning, and handling, should not exceed one per cent.

To meet the first point, it is necessary to keep the machine running continuously, for this is the fountain that supplies the stream of bricks; if this be stopped the stream is broken, or dried up; if, on the other hand, you can keep the machine running, the supply will come without a break. If one hour is lost at the machine it cannot be regained. If the setting gets behind, extra help will make it up; so also with the loading at the kilns. Therefore, don't let any small matter, or a little unusual expense, stop the machine. It may be necessary sometimes to put on one or even two extra hands to keep it running; it is better to do this than stop. There is false economy in stopping the machine to save a little extra cost in labor.

It is true economy to have enough men at the machine to do the work well.

To get all out of a machine there is in it, it must be kept

full of clay all the time, and the machine moving; and force enough to take away every brick that is made, without injuring or destroying any of them by hasty handling. Sometimes there are but two truckers, when there should be three, and in the course of a day, two or three thousand brick are tossed back on that account; all this is lost to save one dollar. Have the machine adjusted and ready to start at the regular hour for work every day; and when that hour arrives let the stream of bricks begin and flow steadily from that moment on until the task is accomplished. To do this, it is necessary to have an extra machine, in case of a break down; and also a supply of clay under shed near by, so that rain will not interfere.

We will suppose the weekly production of a works is 150,000 bricks, one week's expenses $450 or three dollars per M. We will say that labor cost $1.25 per M, fuel costs $1.25 per M, and regular or current expenses cost 50 cents per M. This latter includes salary of superintendent and bookkeeper, other office expenses, horse feed, insurance, taxes, etc.

When the works produce only 100,000 in a week, labor costs $125, fuel $125, and regular expenses are $75, or a total of $325 for 100,000 bricks, or 25 cents per thousand more than the previous week.

Now if your capacity is 25,000 bricks per day—make 150,000 every week—you will find the pay roll will be very little more, if any, than if you made 10,000, or even 20,000 less brick during the week. I find here one great leak in expenses; keeping a large part of your men employed when there is no production to keep up the expense. It is only just and right to give your men steady employment; you are thereby insured a better class of workmen, at a less cost for wages. To do this, arrange your works so you can run up to your capacity every day. This is much better than to buy a second machine during a brisk trade, when you are only

partially utilizing your present capacity. A great mistake is made right here, in buying a second machine; as it requires in most cases more power to run, greater facilities for drying, an increase of the working force, tools, kilns, etc., where, perhaps, half the outlay for machines, driers, kilns, tools, etc., and all the adjuncts of a brick yard, might with good management at all points, reach the object in view, and be much more satisfactory, as well as profitable.

Next comes the point of saving the product after it is made. The brick must be carefully and properly handled all the way from machine to car. They must be dried under cover to avoid loss by rains and dried in a manner to suit the clay, so as to avoid loss by cracking or breaking in drying. In drying, to make the output regular throughout the year, it is necessary to have artificial dryers.

After they are dried they must be properly burned—that is the all important point—burn them well. Next, with the least cost for fuel and labor, as large a per cent. of the whole output as possible should be hard brick, without damaging or destroying any by overburning.

To do this, it is necessary to have permanent walls; and to prevent damage and loss in the arches from sudden changes in temperature, there must, in up-draft kilns, be furnaces and heat chambers interposed between the cold air and the burning bricks.

In down-draft kilns, the air is heated as it passes upward between the outer and inner walls. A kiln must do three things or possess three requisites: It must burn the bricks nearly all hard without waste, and with cheap fuel; and it must be simple to operate and control. It must possess other advantages. It must be durable in its construction, or its advantages will be overcome by the cost of keeping it in repair.

One of the worst difficulties in the way of a steady output, is

to get the green brick dried and out of the way of the machine hands. On most yards the machine, with three days' work in each week, will turn out more brick than can be dried and kilned; then the hands, as a matter of course, have to be changed to another class of work. There is confusion and loss of time in doing this; tools are displaced, the endless litter of the yard has to be rearranged to suit the work; and some brickmakers with racks and pallets are obliged in a stress to hack up the brick that are now dry, in order to make room for more green brick.

Here comes in a loss of time—rehandling and marring of the brick; and that too, generally, in a pressing season, when time is money, and each time the brick are handled adds about 25 cents per thousand to their cost, and detracts from the appearance and value of your product.

To overcome all this loss, and be able to take advantage of all the season, and the wet day as well as the one that follows, we propose in this work to illustrate and explain by detail, the methods which are in use among the most successful of our brick manufacturing firms.

We will suppose you are a progressive brickmaker; that you have attended, or are you going to do so, all the National Convention of Brickmakers; that you take one or more of the excellent publications devoted to the interest of brick men; that you are up to the times and at least acquainted with the different methods of making and burning of bricks. We hope you have a machine and engine, and will assume that you have; and from this as a base, we will begin. We will locate your machine as near the clay bank as possible and as favorable as circumstances will permit to railroad, river, canal, or wagon road; the location of your clay bed with reference to the works, having much to do with the economic handling of the clay as well as the preparation of it.

When anything is done let it be done right, substantial and permanent.

When your engine and machines are set up let them rest on heavy timbers laid on a foundation of solid masonry, or its equivalent; then have them to stand plumb and in line with the shafting. We have seen machines break simply because they were not plumb or in line; in either case the gearing does not work properly, causing extra strain; then comes breakage, expense and delay.

This shows again the importance of having a complete plan of the whole works, when starting a brick plant. A little saving of labor or power may seem an insignificant item at first glance; but when the saving of this labor, hundreds and thousands of times over in the course of the year, it becomes a great and important saving in the end.

When a man starts to build a good house, he hires an experienced architect to make his plans, and specify the materials in detail and probable cost of the same. He can tell his patron where the material can be bought at the least expense for the best quality; and it is wisdom on his part to employ the architect to do this for him.

Now if any brickmaker will turn out his full capacity every day and save it as described in the foregoing, he can make money in the brick business.

Without these points being attended to he cannot succeed; the profits per thousand are too meagre to bear much theory or red tape.

Theory has ruined many a brick yard. It takes a rich firm to stand up under the management of a man who has many theories to explode and little practical knowledge. It is well to be progressive, but not well to sink all the profits in experimenting and changing the order of things, frequently. Get the appli-

ances suited to your clay, location and capacity, and stick to them. Get the best there is among them and push your business. If you are not a practical brickmaker secure the services of one who is, and learn the business.

Never let a customer wait for bricks. If it is necessary, load bricks all night or load them in the rain. Get up a reputation for promptness in filling orders, and your sales will increase. Give your customers good bricks, and ten hundred for a thousand. Talk your business up; explain the advantages of brick over wood, for building; its fire-proof qualities; its durability, etc. Advertise your wares, so that people may know where they can get bricks. Have posters printed with name, address and what you manufacture, and paste one on each side of every car that leaves your works. Now it seems to me that it would be more profitable, as well as satisfactory, to prepare to run your present machinery steady, than to buy more and let it rust out two-thirds of the time, while your employes are thrown out of work in winter when work is scarce. Get a good set of men, give them steady work through the year, and employer and employes will be richer at the end of the year. "Go to," build you a dryer and permanent kilns and sheds, make all the brick possible with the machinery you now have, before going off and buying more, and leaving it to stand idle the greater part of the year.

A brick manufacturer should not shut down his works for want of orders, until he has a good supply on hand; the quantity depending wholly on the market. At some points a half million might be considered sufficient; at other places ten millions would not be any too many.

In order to keep ahead of the market, and make brick in the winter, when the demand is light, it is necessary to have artificial dryers; and this method I think cheaper than natural heat, or air. The bricks occupy less space, and in this way save moving long

distances from machine to drying floors, and from there to kilns; also saves cost of hacking, covering and uncovering. The loss which attends outdoor drying is avoided; certainty takes the place of uncertainty, so far as the quantity of bricks made and saved is concerned.

These advantages and savings will more than pay for fuel required to dry them under cover; where they can be dried in rainy weather, as well as clear weather, in winter as well as summer.

One objection offered against making brick the whole year is, that in fall and winter there is little demand, and provision must be made for storing the product.

Bricks can be moved from the kiln to the stock pile at a cost of from twenty to twenty-five cents per thousand. By doing this, the demand can be met in the busy season, even though it is double the capacity of the machine or yard. When there is a large demand for bricks, the prices invariably rule from fifty cents to one dollar per thousand higher than in the dull season, and this more than repays the cost of storing the brick.

I find in many places, in the spring months, that it is impossible to supply the demand for brick; contractors, in such cases, are compelled to send off for them, shipping them long distances, at a cost of ten dollars per thousand or more, laid down at the building. This causes new yards to be started to supply the demand, and the result is, at some points, there are twice as many yards as need be; which tends to make sharp competition, low prices and unprofitable business. As long as manufacturers supply the local demand with good brick, at fair prices, there is little danger of new yards coming into competion. The wise and successful brickmaker, is the one who, in dull times, looks ahead and prepares to meet the future demand; and when it comes sends out his accumulated millions of bricks at a good price. While his short-sighted competitor says, "If I only had a lot of

bricks," and talks about bad luck and such nonsense. It is lack of nerve and foresight. We have seen this thing repeated time and again, and suppose we will again in the future. A brick manufacturer may not have orders for a hundred thousand bricks on the first day of January, and a million on hand; and by the first day of April following, that million has gone where all good bricks go, (into the wall) and he will have orders on his books for two millions more. This is not a supposed case, but an every year occurrence, with hundreds of brickmakers. "Pile your bricks up." Burn them well, so they will stand the weather, and you have the best stock in the world. The moths will not tackle a hard brick more than once, and it will be the moth that is damaged and not the brick. They are too cheap to steal. They are indestructible. They are fire-proof, frost-proof, and cyclones pass them by on the other side. They never get out of fashion, therefore need never be sold at cost. Where, on this uncertain earth, is there anything so safe as money invested in a pile of well-burned bricks that have been well made?

CHAPTER VI.

BRINGING IN CLAY TO MACHINE.

The method of bringing clay to the machine must depend largely upon your means, or the capacity of your works, situation, etc.

First, is by wheelbarrows, when your clay is within one hundred yards of machine; beyond that it is very unprofitable. One man can pick and wheel clay for five thousand brick in ordinary clay banks with level ground to wheel on.

The next plan is with horses and carts. Two horses and carts with one boy as driver, and three men in the clay bank, can dig and load clay enough to make from twenty to twenty-five thousand brick per day, according to the situation. If the distance is too great, it will require another cart and horse, with driver.

Then comes the tramway and car system; the cars drawn by horse-power, or steam, with cable running over a windlass or drum, connecting with the main shaft of your engine or power. In the handling of clay in this way, I think side dump cars are the best. The best and cheapest car I have seen is a frame on common coal car trucks. The bed or box is mounted on two rockers, like a cradle. The bottom of the rocker is cast iron and has sockets cast one inch deep, one and one-fourth inch in diameter, four inches apart, sockets tapering to the bottom. This rocker rests on a cast iron bar which is fastened to the frame of the car, parallel with the rocker. On this bar are knobs to

correspond with sockets in the rocker, in size and space between. The bed of car is held in place by a strong chain and hook on each side of the car attached to the frame below. When the car is ready to be dumped, the hook is taken from the staple on the side opposite from where the clay is wanted. The car is tipped on the rockers and dumps; the knobs below entering into the sockets in the bottom of the rockers, prevents the bed from slipping off.

I think this can be easily understood, is not complicated in construction, will dump on either side, and generally gives good satisfaction.

There are other devices for dump cars, also a section of track made to tilt and dump the load from car. Where the track is made to dump the car can be made lower and is easier to load in the clay bank; but has this disadvantage, it can be dumped only on the section of track, and a dump car can unload at any point; and in most cases this is desirable.

There are also many hoisting drums manufactured by the machinery men, and all well adapted to the work. Some are engine and boiler complete with the drum, and others are the drum alone, either single or double.

Let the plan of getting clay to the machine depend entirely upon your means, and insist on having the best you can afford.

The plan adopted must depend, of course, in a great measure, upon the situation of your clay bank.

If, as is sometimes the case, the works are at a point below the clay you have a great advantage, in being able to move your clay into place on tram cars, by the force of gravity alone. That is, you can arrange your track and tram cars, so that a loaded car will descend and draw up an empty one.

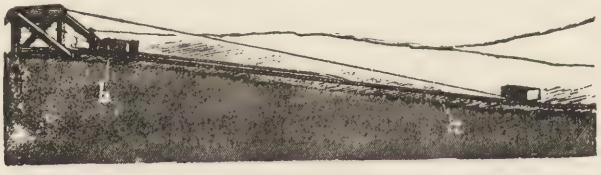
But, if, as is most usually the case, the clay is below the line

of works, then it becomes necessary to use steam, or horse-power to get the clay to the machine.

As was shown in a previous chapter, we prefer to elevate the clay high enough above the machine, so that a sufficient amount clay can be left on the platform to make one or two days run of the machine. This constitutes a reserve bank that can be drawn on, in case of a rainy day, or flood in clay bank, break down of the inclined tramway cars, or any other unavoidable accident, or delay. The loaded cars can be drawn up the incline with whatever power is most convenient; a light locomotive, or an endless wire cable running over a drum, and connected with the main shaft, or a separate hoisting engine, or a horse railroad.

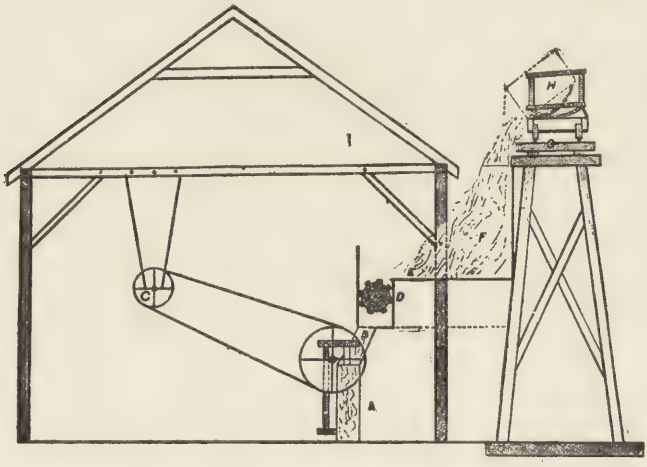
We are speaking now of works that are designed to make a considerable amount of brick, and the smaller yards will pardon us, if we have described, or illustrate methods, that are not suited to their means or capacity. Our wish is that you may have the advantage of all the improved methods of manufacture.

We give herewith an illustration of an inclined tramway or cable railway, which can be built and operated at moderate expense.



In this diagram, "a," is the inclined railway; "b," descending car; "c," ascending car; "e," endless cable; "f f," upright posts of frame; "g," drum or cylinder, supported by frame. The cable should pass twice around this drum, to prevent its slipping; one end of cable is running on, while the other is running off.

There must be a double track from the hoisting drum "g" to a point below where the cars pass; a single track will answer for the balance of the way down. Where the clay bank is above the works, the loaded cars going down, bring up the empty one; but where the clay is below or near the level, then power must be applied to the drum sufficient to move the loaded car up the incline. A lever of sufficient length and strength, with one end passing over the drum, can be used for a brake. The cars also should have a brake for safety. The cable should be of wire from five-eighths



to seven-eighths of an inch in diameter, according to the incline. If you use hemp cable, of course it must be heavier. The cable must have idlers, or rollers, on bottom of track between the rails to prevent friction, and wear on cable.

By this plan only a single length of cable is needed with sufficient surplus for the two laps or turns on the drum, "g." This drum should be not less than thirty inches in diameter.

To handle clay economically, it is necessary to elevate it by steam or horse-power above the machine.

There are two ways to elevate the clay. One is to dump on the ground level, and carry it up to the preparing machine by elevators. The other plan is to elevate it before it leaves the car or dump cart. I prefer the latter plan and the following diagram shows this method.

It is simply an inclined railroad. The cars can be drawn up the incline by a stationary drum or cylinder, or with horses or a light locomotive, where bricks are made in large quantities.

The following specifications and letters refer to above diagram: "A," is the brick machine; "B," inclined hopper, through which clay passes from the preparing machine to brick machine; "C," line shaft, from which any number of machines can be driven; this, as shown, is twelve feet above the floor of the machine room. "D," is the pugger or tempering machine, or it can be a crusher or disintegrator; "E," platform on which men stand to feed the preparing machine; "F," is the clay as dumped from the car; "G," is the elevated track; "H," is dump car on the elevated track; "I," is the building.

In this plan there is sufficient room at each machine to hold clay enough for a day's run of the machine; so that during a rainy day, the machine can draw from this reserve clay.

There are other plans which may be better in some locations, the position of the clay beds with reference to the works, having much to do with the mode of handling clay to the machine economically, as well as the preparation of it.

Preparation of clay is an important matter in the manufacture of bricks. Often this part receives but little attention; the clay is brought from the bank and dumped at the machine, some water thrown on it and it at once goes into the machine. Throwing water on clay in this way has about the same effect on the body of the clay, as water thrown on a duck's back has on the duck.

When clay is dug in the bank during the dry season and

made into bricks, with the preparation described above, the result will be that a large amount of the bricks will be imperfect, and have to be thrown back, causing a loss to the output of the machine of at least ten per cent.

Clay should be soaked for a few hours, or passed through some tempering machine, crusher, pugger, or disintegrator, before any machine can make them perfectly and without loss. The amount of brick saved by proper preparation of clay will soon pay for machinery necessary to do it, besides making a better quality of bricks.

These machines also save re-handling of the clay, where it can go direct from the bank to the machine. It saves the labor of two men at least, at each machine, and protects the brick machine from stones, bolts, spikes, or pieces of wood, and this saves the machine from breakage. The diagram just given shows how these preparing machines may be located with reference to machine and tracks.

CHAPTER VII.

MACHINES AND THEIR ADAPTATION TO THE WORK.

With all due and proper respect to the inventors and manufacturers of clay working machinery we must admit that we, as all others interested, have our preference for certain or special machines. Some prefer one class of machine, or a particular machine in that class. Other brickmakers, located in the same neighborhood, will prefer a still different machine altogether. And we have lately been through sections of the country where many millions of brick are made annually, and found a great many manufacturers who ignored altogether, all machinery for molding bricks. Richmond, Va., is a notable example in this respect. There are but few machines in use there. Manufacturers prefer to keep up the old style, hand-molded bricks. There is one thing to be said in favor of these men, they all, without an exception, have an engine to drive their tempering wheels; but where brickmakers are so slow to adopt all labor-saving methods and are not using brick machines, one expects to see the old style mud mill or tempering box, with the blind mule, or ox team as a motor. Also in the neighborhood of Baltimore and Philadelphia will be found many yards run on this very primitive plan.

There will always be a difference of opinion in regard to machines for the use of brickmakers and clayworkers. But it is not every brickmaker or machine manufacturer who will go to the bottom and find the reason for this difference.

I once met a brickmaker who was using an old style soft mud machine, and that, too, apparently at a great disadvantage. I asked him why he had ever been induced to buy such a machine, when there were so many that were superior to it. His reasons were that he was well acquainted with the manufacturer and he always liked him, and that was the reason he bought the machine. Most brick men will give a more practical reason than this.

Each manufacturer will claim that he has the machine that will do all that is required to disintegrate, pulverize, or separate the stones from the clay, or will thoroughly pug, mix, temper, mold and discharge, at a certain rate per day, a given number of bricks; and under certain conditions and circumstances, most machines can be made to do all that is claimed for them. But there is, as yet, no one machine, that will work all kinds of clay, or that has proved itself to be of universal adaptation. And, for this reason, it is best to go slow in buying expensive machinery on simple statements alone. The purchaser should first satisfy himself that the machine will do the work required of it, or make such arrangement with the manufacturer, that if it will not do it, the machine must be returned to him at his expense; as the loss falls directly upon the purchaser, if it does not come up to the guarantee, if he has not taken some such precaution in the matter.

Machines are usually built to suit particular kinds of clay, and will work that one kind only, profitably. It may be necessary to examine the clay question in this connection. Let us see: The difference in the composition of what is used as brick clay is so great, that of a necessity it requires different machinery to work it. In one place the clay will be deep in the bed or deposit, free from stones, gravel, or anything like sand or grit; while in another location, the clay may be equally as good and yet scattered through the deposit, will be fragments of flint or gravel varying in size from one inch to one foot in diameter.

Where the rocks are large and infrequent, they can be separated from the clay in digging and handling before it reaches the machine. But where the rocks are small and frequent, then it requires special machinery to separate them from the clay. In case the stones are small and not of a lime formation, they can be crushed and worked up with the clay into common building bricks; but for fine pressed brick, for front facing, or ornamental brick, clay is required that is free from stones or gravel, or the stones must be crushed to a fine powder and worked up with the clay.

Where the stones are of a limestone formation and are left in the clay, burning the brick burns the stone into water lime, and on exposure to the weather, even to the atmosphere alone, the lime is slacked and bursts the brick.

The same thing occurs along the Mississippi River, and other large streams, or near the coast where the clay deposit is of recent formation, and contains wood or snail shells, periwinkles, etc.; these form lime spots in the brick and ruin great quantities. Now it is evident that the machine that would answer to separate the rock, or crush it in one clay, would not perform the work in the clay that is filled with fine pebbles, or winkles.

A manufacturer located in a section of country that is all underlaid with clay varying in depth from five to forty feet, clean in its composition, free from all rock or sand, will most likely manufacture a machine first, for his own use, or the use of a brickmaker in his neighborhood. He will experiment with his machine, and perfect it to work the clay of his locality, or that of the adjoining towns or counties; and in this way he is called upon to make a machine for his neighbor or competitor. The machine is thus put to trial with this clay, or that which is similar in its composition. But should his trade, through advertising, grow on his hands, and he receives an order for a machine at some remote

point, and sends it to the customer without a trial in the clay of that section, the chances are there would be two men badly disappointed. I have known just such cases as this. The clay that is well adapted to stiff-mud machines, is not so well adapted to soft-mud machines.

The stiff-mud machine will work the clay direct from the bank, providing it is clear of stones; while the soft-mud machine would require a pugger, or tempering wheel, to prepare the clay before it entered the brick machine.

A clay of a loamy, friable nature, with a large percentage of fine sand, will work better on a soft-mud machine, while a fine plastic clay is suitable for stiff-mud machines.

All soft or stiff-mud machines with which we are acquainted, have a grinding shaft, with a series of paddles or arms; or, in some, a screw-blade, set to force the mud or clay downward or onward to the point of discharge. These paddles must be set firm and solid to the shaft with adjustable bolts, and at an angle or incline to feed the machine no faster than it will discharge the clay, as made or finished bricks. If set at too much incline, it requires more power to run the machine; and the clay is forced backward in the box, or body of the mill; and is consequently in danger of breakage at some point, because the clay is forced downwards faster than it can be fed out as molded bricks.

I do not propose in this chapter to champion any one machine, but only speak of the care and attention necessary to keep any machine in good working order. First, study your works, and the advantages of one position over another, for the location of the machine. Determine on the heighth to the top of the machine, and arrange so as to bring the top of machine as low as possible to save labor in feeding it. A great deal of heavy labor is saved by bringing the clay up near the top of the machine, or what is better, above the top, and then it can be fed with one

man; where, if it has to be lifted up with shovels, it requires two men; and in a great many cases, it is necessary to dig a pit for the foundation of the machine, and make a drop below the floor level from one to one and a half feet, or more, as the case requires.

This, in a great many places, is a very great help in the matter of feeding the machine, or getting up the clay, and is little or no detriment in the working of the machine or arrangement of works. When the machine is so placed, the floor must be graded down to allow the trucks to come into the machine and be pushed out with their load of green bricks readily and without confusion.

Some clay is filled with roots that penetrate to a great depth and are carried to the machine in the load. Once in the machine, these fine roots hang on the paddles or arms, and where they are numerous, they are a source of great annoyance by hindering the downward passage of the clay.

In order to feed well, the clay must be cut with a knife edge and clear the paddles and they push it onward, while if allowed to clog with any fibrous material, soon push the clay back out of the way of the paddles, and the feeding ceases.

One great point in running a brick machine is to keep all the wearing parts thoroughly and frequently oiled. Where there is two or more machines in steady use, one man should have the oiling to attend to as his constant duty; to oil all the bearings and cog wheels; and if it is a stiff-mud machine, the molds, or dies, are to be constantly supplied with a sufficient amount, and no excess or waste of oil. I have found that where there was a bearing neglected in the early part of the day, and it got hot, that the heat expanded and tightened other parts of the machine until it became necessary to stop and cool off; then by starting right and keeping oil on the boxes and journals, everything would go off all right all the rest of the day, and run at a much higher rate of speed than before.

There is, on most machines, some parts that are subjected to a jerk or push at each revolution or discharge of the molds, and it is not an infrequent occurrence for bolts to come loose or break off. This should be carefully watched, and all taps kept tightened, and parts of the machine in place, thereby saving breakage and consequent stops; all the joints and packing looked after, and no leaks allowed to scatter clay under the machine, over the oil boxes, and among the cogs, or any place where it will cause trouble or annoyance. The machine is calculated to receive clay in the box or cylinder and discharge bricks at a given point. If it is built so it will not do this, get one that will.

Another point is, to arrange your belts so that they can be slacked up, and the machine stopped in case of a break-down, without a journey across the yard to the engine house. Another plan is, to connect the governor valve on the engine with a cord running to the machine, then, in case of a break-down at the machine, the workmen there can have control of the engine and stop in a moment.

CHAPTER VIII.

DRYING BRICKS.

Bricks are dried by air currents which absorb the moisture from the green bricks by contact with them. The drying power of air currents depends upon their temperature and velocity. Dry, hot air moving fast, absorbs moisture rapidly, while a cold, damp air moving at any rate of speed will dry slowly. Green bricks dry slowly even when the sun shines hot, if there is no breeze, while they sometimes dry rapidly in cloudy weather when the wind blows briskly. The atmosphere in this respect is like a sponge; when the sponge has absorbed a certain amount of water, it will take up no more. When the atmosphere has absorbed a certain amount of water from the brick with which it is in contact, it will hold no more and the brick cease to dry. If, however, fresh air is continually replacing the moist air, the brick will continue to dry until they are as dry as the atmosphere; at this point, they cease to dry. By the use of artificial heat, forced draft, or currents of dry hot air are brought in contact with the brick, drying them by carrying off moisture as it is absorbed. All drying is the same in principle, and differs only in degree. The drying of bricks is a matter of more importance than the average brickmaker would at first thought believe.

We will suppose that the yard is arranged to run constantly, and turn out twenty-five thousand bricks each day, three hundred days in the year. This is an output of seven and a half million

of brick annually. If these bricks are made by the soft mud process, they will each contain when made, one and a-half pounds of water, at the lowest estimate. This would require us to evaporate over thirty thousand pounds of water every day, Sundays and holidays all counted in on the drying. This is a very low estimate, and might safely be calculated as equaling twenty tons of water that has to be got rid of every day before they are fit to burn; or, rather, before it is safe to attempt it.

Which is the best and cheapest method of drying bricks?

Let us look at the matter now in a business way, at the different methods. First is the good old way (but not the best) of the sunshine process, where the bricks are spread out on the ground to dry in the sunshine. Every brick man knows the work and the worry and uncertainty of this way. I was urging the importance of some more reliable method of drying bricks to an old brickmaker at one time when he, to meet my argument, suggested that there was nothing cheaper than sunshine. I admitted that much, and still support the old "gent" in that point, but I could not resist the reply that was ready—that there was nothing that I could call to mind that was so little to be depended upon. I left him with his bricks out in the sunshine drying, over an acre or two of open field. The season was what was called showery; not excessively wet, but the air was damp; the clouds were frequent and heavy. I went back to call on him some six weeks later to see how he was coming on; piles of wet mud were numerous all over the yard; he was busy with a force of hands, sorting the broken bricks and dissolved clay, from among those that were passable; hack after hack was tumbled down in a pile of ruins; he showed me one pile of several thousand bricks that had gone through the pug mill five times already and was ready to go back and repeat the process again. Sunshine may do in Egypt, but not in this uncertain latitude.

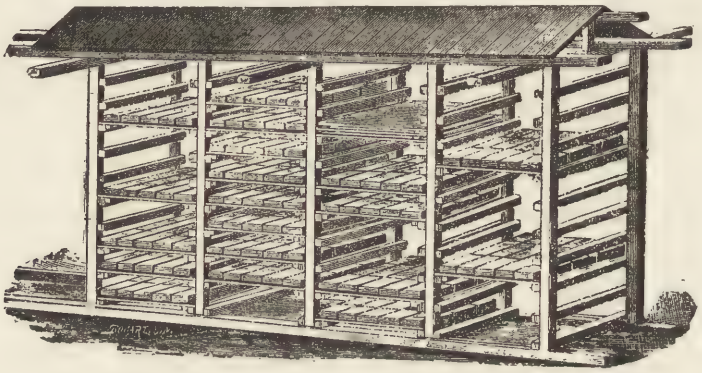
The advantages of sun drying are that it costs very little to prepare the ground for drying the brick; and sun heat costs nothing. The disadvantages are that while it is furnished without price, there is no certainty about the supply and it comes without any regularity; and sometimes for weeks at a time, no brick are dried; hence the brickmaker who depends upon this process of drying has an uncertain output, indeed. Still there may be more certainty about the output, than the amount he puts in the kiln, as the brick are not only exposed to rains, but in the spring and fall months they are liable to be frozen, and the percentage of bricks lost will average at least fifteen per cent. of the amount laid on the yard. There are only six months of the year that they can be dried in this way, or any other method of natural heat; and only part of this time is available.

Where bricks are made in large quantities, it requires a large area for drying them, as it must contain nearly a week's production. This necessitates the moving of the bricks long distances from machine to yard, and from yard to kiln.

This method also requires the handling of large quantities of lumber to protect the brick; and necessitates a great deal of labor, and destroys in a season many thousand feet of the very best lumber. I have frequently been on yards that used lumber for covering green bricks, that had to be lifted off the bricks in the morning and lifted on again at night, and shifted about to get at the dry brick, or for other reasons; and if the lumber had been in suitable shape there was enough of it to build a first-class shed over a furnace dryer; and such a covering is always ready, not in the way, and don't have to be moved about.

The second method of drying by natural heat is the shed system; this is where the stiff mud brick are hacked direct from the machine, under large open sheds, and dried by natural air currents.

Brick will dry in this way, but very slowly. The hacks on the outside of the building will dry in reasonable time, while further in from the walls or posts, the brick will stand for many days without any perceptible change. Soft mud brick are dried on the same principle by using pallets. The pallets are made of light lumber, a little longer and wider than the mold, and have a foot piece at each end about ½-inch higher than the green brick are thick. The pallets can then be placed one above the other in tiers, and left in this way under sheds or in the open air until they are sufficiently dry to hack in tiers, and support the weight of six or eight courses.



If you adopt any method of natural heat and air currents, let it be the the rack and pallet system; that is, placing the bricks on pallets under a narrow shed; the pallets being suspended on tiers of cleats, or strips, which are nailed to 2x4 upright posts. The objection to drying by natural heat is the risk of damage or total loss of brick by rains and otherwise as before stated.

Then there is the uncertainty about the amount of production in a given time; and the anxiety, worry and general wear and tear of the proprietor.

The pallet system is advantageous with soft mud bricks, for

they can be dumped from the molds at the machine; this prevents sticking in the molds, and when placed on pallets they can be put in racks or tiers, one above another, and a large quantity can be stored in a comparatively small space. When the racks are provided with projecting roofs or canvass sides, they save the brick from damage by rains, or checking during high dry winds; so that the shed drying and rack and pallet system, are a great improvement over the old style sunshine mode. But they are open to the same objections that the sunshine method is; that the bricks will not dry in damp weather and are liable to be frozen in cold weather.

The general advantages of artificial drying over natural heat are many, without reference to one mode of artificial drying, over another. I will endeavor to make plain some other of these advantages in addition to what has already been mentioned. With an artificial dryer, and a machine that will produce twenty-five thousand brick per day, a brickmaker can make from six to seven millions of brick per annum. To dry without artificial heat, would require two machines of 25,000 capacity each, or more, to produce the same amount of brick in a year. Now in case he has a dryer, he can with half the labor, half the tools and power, and consequently with little more than half the capital, produce the same result. He can then give his employes steady work, and in this way gets a better class of men for perhaps less wages. There is much less worry and responsibility when he retires at night. He has no anxiety about a storm coming up in the night, and damaging or destroying his day's product; or perhaps a week's labor may be swept away, and his yard in such a condition he can make no more brick for several days.

To put brick on a yard where they are exposed to storms, is an uncertain, unprofitable, and vexatious way to do. I have many times seen a whole week's product destroyed, leaving the yard in

chaos, and the proprietor in about the same condition. I find but very few men who can look upon the total wreck of one hundred thousand brick, with any degree of composure or refrain from using fretful language. Drying with artificial heat, you save all the ware; you can dry brick when it is raining, and even when it is freezing. There is no loss of time on account of bad weather dura rain or a damp spell after a rain when your yard is in such a condition it is impossible to do any work on it until the weather clears and the yard dries.

Again, in most markets, prices are better in the spring months than any other time of the year. If dried by sunshine, they must be made during the early part of the preceding autumn, and the stock carried over six months. With a dryer the entire season's product can be sold the same year, and by the first of March or April, the spring stock is ready for market at a good price, and you can without risk contract for future delivery, knowing that you can fulfill your contract. How is it with the manufacturer who has no dryer? He has no assurance that he can fill future orders, and in most cases here is where he comes in competition with other brickmakers.

The cost of dryers some will say, is an objection. I think from a careful reading of this chapter, and then comparing it with your experience, you will see it is just as expensive to dry brick by sun and air as it was to make by hand instead of by machinery. Drying brick by artificial heat is generally acknowldeged by progressive brickmakers to be the best and cheapest plan. There has been a decided change of opinion upon this subject in the past five years. I receive many inquiries about dryers and brick drying.

There are a number of devices for drying bricks with hot air, that are patented, and advertised, and in some places are in operation; and it is claimed doing good work. It is well enough to in-

vestigate their merits as to cost, ease of management, and results; and among all the dryers, choose the best or the one most suited to your needs. When a brickmaker spends one or two thousand dollars on kilns, or dryers, or a machine, if they are good and durable, he has added just that much to the value of his plant. And is it not just as much the privilege of the brickmaker to have good machinery, and a full line of first-class equipments, in the brick business, as any other manufacturer ?

I think you will agree with me in this at least, that he does more work and handles a larger amount of ware, for a smaller margin of profit, than any other manufacturer. He handles a ton of clay many times in the process of making and drying; then burns it a cost of from fifty to seventy-five cents a ton, delivers it at from one to three miles to market, for about $2.50 or $3 per ton. At best the margin is small. Show me a manufacturer who works under as many disadvantages for a smaller margin. For this reason he must watch the little leaks of his profits. The waste in making, drying, burning, handling, and delivering, must be avoided at every possible point.

The cheapest mode of investigating machinery, is to visit the fairs and expositions, where such machinery is on exhibition, and in operation. But to investigate kilns and dryers it is necessary to visit the brick and tile works, where they are in use; as they are a class of manufactures than cannot be carried around. The machine, kiln or dryer, that cost least to build or to operate, is certain in its results, and is durable in construction, is the kind to purchase. Then study to make it a success.

There is another method of open air drying that deserves some mention here, and is well adapted to small yards running one or two machines; that is the system of hacking on pallets about from thirty-five to fifty bricks on each pallet, and moving them into position on the yard with portable hacking trucks. The

brick are hacked in open order, three or four courses in height as they are made at the machine. Stiff mud bricks are hacked on edge direct, on top of each other, the brick being placed over the space below, each hack with the same number of brick. Soft mud brick are dumped on the pallet and set one above the other; a foot piece on lower side of pallet, interposed to keep them from coming in contact with the bricks on the pallet below. These are lifted from the ground by a device of levers, and are then in position between the wheels of the trucks at a few inches from the ground, and can be rolled to any point on the yard, and again with the levers lowered to rest them on the ground where they are to remain till dry. By placing them in straight lines, and at a right distance from each other, giving space enough for a free circulation of air among them, more brick can be hacked and dried on the same space, and do not require to be touched with the hands till the tossers take them in the kiln. They are then placed right on the yard in good position for covering with boards or battens to protect them from storms of wind or rain.

They can be placed two rows close together and economize space on the yard in that way, and light movable battens can be made to shelter them with an A shaped roof, which sheds each way and is a good protection. The pallets with their loads of brick can be taken when dry and moved to the kiln direct, without re-handling, by use of same hacking trucks, and left ready for the tosser. The greatest disadvantage is they cannot be used in such a manner as to keep a large force of setters employed. The trucks are larger than barrows and occupy much more space to be handled; the pallets as emptied are getting in the way all the time and more than two trucks at a time cannot well work in a kiln at same time. Six wheelbarrows are of more consequence than three trucks.

Yards with a large capacity and heavy output must be pre-

pared to keep up each day, and all the time, the output at the machine without jar or confusion, and all the work must be brought into small compass, and open yards cannot be so managed as to secure these results.

There are times on most yards when the weather is in such condition that the brick dry by the wind alone, and when the weather is cloudy and no sunshine, the brick may be dry on the side of the yard opposite to the kiln, the wind having been on that side. When this is the case, the trucks are of less service than wheelbarrows, as the barrows can be moved in a much smaller space than the trucks, and the trucks have to be discarded to get at the dry brick. Then, after rains, if the yard is inclined to be heavy, runways of planks can be laid down and wheelbarrows used when the trucks would not answer.

There are some yards using the portable trucks, and handle them with a small mule and stiff traces provided as shafts for the trucks which are detached and hitched to the next loaded truck very readily. A man goes with the mule to drive and guide the truck, and load and unload the truck. But I find such yards do not make over two or three million brick per annum. I believe this plan is very far superior to that of dumping or hacking on the ground. The system cannot be compared to the rack and pallet way, as there is no way of covering them from the weather that can be called convenient or reliable, as in the rack and pallet method. Where brickmakers are wanting to change from the old way of soft mud brick dumped on the ground to some better method and do not want to make large outlay for dryers, we would recommend the portable hack as a good move in that direction. Three of the trucks will answer for a one machine yard, not less. as there must be provision made for an extra, in case one is needing repairs. There is always danger of breakage with the trucks, as the load is heavy. If you use a mule, one hundred bricks is a

load, and the weight on the truck is over six hundred pounds; if pushed by hand the load of forty-five bricks and pallet, is about three hundred pounds. This weight is hung below the axle of the truck in such manner that any inequality of the ground may cause the load to swing sideways and the pallet to strike the spokes of the wheels, breaking them out; and the construction is such that there is a weakness in the gearing, and they are soon out of repair, and loose jointed.

CHAPTER IX.

DRYERS AND THEIR CONSTRUCTION.

Brickmakers who want dryers, and do not feel able to put up one equipped with pallet cars, tunnels, tracks, fans, coil pipes, etc., can put up a flue or hot floor dryer, with less outlay for material and labor, than any other reliable dryer.

The following plan of construction I consider the best and most durable, when cost is considered, and most brickmakers are obliged to study economy in every department of their business.

The flues should be from one hundred to a hundred and fifty feet in length, between the furnaces and smoke stack. It is always a matter of economy to build the dryer as long as you can, as the heat will answer to warm the floor of the extra length over a hundred feet from the furnaces with but very little more expense for fuel and no more expense for firemen.

Grade the foundation for the flues, so that it rises twelve inches from the furnace to the smoke stack at the opposite end Let the flues open into a cross chamber which connects them with the smoke stack. This chamber should be as high as the flues, and extend downwards twelve inches below the bottom of the flues, and about sixteen inches in width. This allows any soot that is not drawn into the stack, to fall from the flue and be deposited in this soot chamber, which can be arranged to admit of cleaning it out occasionally, and thus prevent its accumulating in the mouth of the flues, to stop draft.

Beginning at the furnaces, the flues are started on a wall at the rear end of the furnaces, twelve inches above the grate bars At this point they receive heat from a distributing chamber which in turn connects with the furnace. This chamber should be sixteen inches wide, and six inches higher than the top of the flues, and covered with an arch or large, flat or curved tiles.

The flues should be five inches wide in the clear, and separated by a wall built with a single witdth of brick laid four courses high. The first five or six feet of these flues next to the furnace should be built of fire brick and the furnaces and chambers lined with fire brick. All this work can be built up with clay mortar, with a good proportion of sand to make it work off the trowel freely. The flues are to be covered with bricks laid either on their flat sides or on edge. The partition walls can be of salmon brick. The cover or cap brick should be sound, hard brick.

Over the top of these cap brick or cover to the flues, is a cover of tempered mud just stiff enough to work down well with the trowel, into all the joints and spaces between the ends of the bricks, and as this mud dries, roll it with a heavy roller, closing up all cracks and openings caused by shrinkage. When it gets too hard for the roller to make any impression upon it, it must be tamped with a large block rammer until it is hard and nearly dry; then grout the floor with thin mud until dry and air tight, then pave with hard brick, bedded in thin mud, and made as level and even on top as possible. The tempered mud should be put on, so that when the floor is finished the whole thickness including cap brick and pavement, should be as follows: At the end next the furnaces twelve inches, and gradually reduce to eight inches when half way back to the stack, and from there to stack reduce to five or six inches.

This floor if properly constructed will dry stiff mud bricks set on end close as can be handled readily, once every forty-eight

hours, or it will dry soft mud brick laid on flat sides, once every twenty-four hours.

The capacity of these floors with stiff mud bricks is ten to the square foot; with soft mud bricks, two and half to the square foot. With flues one hundred and fifty feet long, the stack should be at least fifty feet high. A stack of this height, with a flue twenty-four inches square inside, will answer for a dry house floor forty feet wide, by one hundred and fifty feet in length, and a dryer of this size will dry thirty thousand stift mud brick, or fifteen thousand soft mud bricks, in twenty-four hours.

The roof can be put on with a single span, and a comb in the center, or a lighter roof can be put on with a valley in the center, supported by a row of posts through the center of the drier. These posts, and all others about the shed should rest on brick pillars, so that they are at least eight inches above the floor of the dryer. There is then no danger of fire being communicated to the posts from the flues. Most dryers of this kind that are burned down, catch fire from the posts being buried in the brick work or ground near the flues. The building should be covered with a shingle, tin, or gravel roof. You must have something that is water proof. A dryer roof that leaks, is but little better than none at all, as it damages the brick and makes the floor damp, which prevents the brick from drying evenly.

The building should be provided with eave troughs to carry off the water that falls from rains; and also with drains to carry away all water from the building, because if water is allowed to settle in around the walls, and penetrate the flues, soot will then adhere to them and clog them up or very much impair their usefulness in radiating heat.

When the flues need cleaning, make an opening across the floor of the dryer, into the flues wide enough to work in comfortably, and about thirty feet from the furnace; make other openings

about the same distance all the way back to the stack; take a heavy wire of sufficient length to pass through each flue from one opening to another with a plug of wood on the end to prevent its getting hung on the brick work; fasten a bunch of old sacking or rags on the other end, and drag it through one flue at a time, until they are all swept clean. After this bundle of rags has gone through one flue, it is dubbed "the black cat," which name is very appropriate. Another way to effectually clean the flues is to make a steam connection with the boiler and carry a one-inch pipe back to the openings made in the floor, or as near as conveniently can be done, and then with a short piece of hose inserted in the flue openings, and the steam turned on, the flues can be swept quickly and thoroughly. I have also had a patch of soot collect on the dryer floor and stop up a few feet of three or four flues, stopping the draft at the rear end of these flues, and injuring all that side of the dryer. Where you have reason to suspect any such trouble, it can be helped sometimes by taking a couple of buckets of water and dash into the furnace, a half bucket full at a time, on top of a strong fire; this generates a flash of steam that rebounds out of the furnace door, and also acts on the flues, and if the soot is not too heavy, will tear it loose and the draft will be free for a time; if this does not remedy the draft, clean out the flues, as it is a poor plan to waste the space and fuel on your dryer floor without the results for which it is intended. In this way the dryer flues can be thoroughly cleaned without much trouble, and very little loss of time. By cleaning out one furnace at a time, or half the dryer, there need be but a very short stoppage of the works. It is a good plan to take advantage of any other stoppage or break down, to drop the fires in the dryer and clean out the flues about twice annually; do this as fast as can be done without letting the floors cool off entirely, as in so doing there is a waste of heat, and a saving of fuel in drying brick all the time, as soot adhering to the flues prevents

the radiation of heat, and it passes up out of the stack. The smoke stack should be provided with a damper, so it can be closed at night, or when the fires are banked during a temporary stoppage of the works, to hold the heat under the floor and in the flues.

There should be a furnace about three feet wide and five feet long with grate bars three feet, or three feet eight inches long, making from nine to twelve square feet of grate bar surface, for each ten feet of width of dryer.

The slack or coal bin must extend at least ten or twelve feet from the front of the furnace. Coal slack as fuel will make all the heat required. Where coal costs too much and wood is cheap, then use wood. The furnace may be the same size as for coal, only a less number of grate bars are needed, and they only in the middle of the furnace. The space on each side of the grate bars can be filled up in the ash pit with a course of brick, as a dead wall on each side of ash pit up to a level of top of grate bars. This only where wood is the fuel, as when coal is used, more room is needed for ashes, and more draft is required. Such a dryer will dry bricks as well as the most costly and expensive dryer; but will cost more for fuel and labor in handling the bricks, as they have to be re-handled to take them from the trucks or barrows, and place them on the floor of dryer, and then again lift them from the floor to the barrows before placing them in the kiln; while in the tunnel dryers, the brick go direct from the machines to the kiln on the drying cars and are not touched by hand; thereby saving expense of two handlings, and consequent damage to the unburnt bricks.

There is another system of drying brick with exhaust steam, that is working its way into notice, and is in use on some yards, but which has not yet been perfected enough to commend it to the favorable notice of brickmakers, as a safe, expeditious and re-

liable means of drying, when the steam is used as a means of heating the floor of dryer.

There are several reasons for this; among them is the first question of cost. A dryer built forty-two feet wide, by eighty-two feet long, will contain inside the wall space, floor enough to hold thirty-two thousand bricks set on end; allowing ten bricks to each square foot of surface. Brick set on a dryer floor should be dry enough in from thirty-six to forty-eight hours, to be removed and give place to green bricks. Our experience is that on this floor they cannot be dried sufficiently in four days, during the winter months or damp weather, to be set in the kiln and be safe against freezing or crushing from water-smoking.

There is in a dryer of this size nearly seven thousand feet of steam pipes. These pipes lead from a distributing pipe at one end to a waste pipe at the other end, laid with sufficient fall so that condensed steam will flow to an outlet provided for it at the lowest point, and below the level of the pipes in the dryer. This allows for a one-inch pipe every six inches over the whole width of the floor, and then when the pipes are all in and safely adjusted, leaks all stopped, valves all ready to turn steam on and off, then comes the next question of a floor covering, suitable for hacking brick on. I have seen such floors laid with green or stiff mud bricks well rammed and dried in around the pipes; but they were soon ground to an impalpable powder by the heels of the men and the wheels of the trucks and barrows.

This was a great detriment to the bricks both in appearance and in preventing them from drying. The dry dust acting as a non-conductor between the pipes and the green bricks. The wheels of the trucks would also cut through and pound over the pipes making them leak, or drive them deeper into the floor, which caused a low place for condensed steam to collect, and rendered the lower end of the pipe useless, by being filled with cold vapor or con-

densed steam. Then again I have seen the spaces between the pipes filled with brick, and cement, or clay mortar filled in over the pipes between the bricks. This made a very rough, uneven floor, obstructed with dust, and very troublesome, as the wheels of the trucks would fall into the spaces between the bricks and tear out the mortar, and knock the brick loose, or break down the loaded trucks of green brick causing confusion and delay. This has but one advantage; the green brick are nearer the pipes and dry faster as the pipes are nearly on a level with the top of the bricks which go between them.

A brick floor or pavement on the top of the pipes is a good serviceable floor, but the heat is slow in passing through, and is never very great. This floor is an excellent one for repressed brick drying; but for common stock the brick must dry in quicker time. The floors of a dryer should be smooth and hard, and be kept swept clean ahead of the trucks and green hackers, so that the green brick will not pick up particles of dust or lumps of clay which will adhere to them while in a soft state. I have seen no floors of iron or cement that were cheap or practical, as iron plates could not well be laid over the pipes and made serviceable or cheap; cement if it is bedded around the pipes is too unyielding and causes breakage at the joints or connections; or it will, like the clay, soon return to fine dust by the wear of the wheels.

Where steam is used to heat the floors, the exhaust from the engine is expected to keep up the heat during the days, and with suitable connections, live steam at night. We have yet to see any great difference between exhaust and live steam with ninety pounds pressure from a forty-horse boiler.

There is always a back pressure on the engine while using exhaust steam that impairs the power, making it up hill work for your engine all the time. This will be more noticeable on a small engine than on one of large power.

Then, again, in counting the cost of drying with live steam at night for four or more nights, with labor, fuel, etc., and the more extensive sheds to hold the four days run of brick, and your brick not thoroughly dried, which eventually has to be done in the kiln after they are set for burning, with fuel and labor added there, and by counting the cost of fuel and labor at both points, our experience is, that a furnace dryer is much more satisfactory and reliable, both in point of time and economy.

A floor dryer can be constructed in the following manner, to use either exhaust, or live steam, or both: Grade your floor with a fall of eight inches in one hundred feet; have the highest end next to the boiler; cover this surface with one-inch steam pipes in hundred feet lengths; lay these pipes in parallel lines, six inches apart from center to center; these pipes connect at right angles with header pipes at each end; the receiving header, that is the one nearest the boiler, connects with a pipe which in turn connects with the exhaust pipe.

These three pipes should be of equal size, and the steam should enter the receiving header at a point equally distant from each end, so the steam will be distributed equally through it. The header at the opposite end, can be one less diameter. The header pipes at both ends should be two inches lower at one end to allow the condensed steam to flow out; at the lower end, place a globe valve, a little smaller than the header pipe; with this regulate the volume of escaping steam and water. Some use steam traps, but they are no better than a globe valve of sufficient size. The receiving header pipes should also be provided with a one inch globe valve to drain it. By placing a globe valve in the exhaust pipe, above the point of connection with pipe leading to dryer, the steam can be allowed to escape through it without passing through the dryer.

After the floor pipes are laid and straightened, there will be

four and a half inches of space, between the line of one-inch pipe. Lay a line of burned bricks with their ends together, so that their top surface is one-half inch higher than the pipes; fill the space between the lines of brick with a mud mortar, covering the pipes one-half inch; then over all, lay a smooth pavement, herring-bone style, of smooth, hard bricks, bedded in mud mortar as they are laid. They will be supported by the bottom bricks so that the pipes have no weight on them, and can expand and contract without breaking at the joints.

The header pipe at the lower end should rest on skids, so it can move when the pipes expand with heat, and return when cooling. The live steam pipe runs from boiler to exhaust pipe, and at night can be used to keep up the heat in floor, when the engine is idle.

Nearly all floors of this kind that have been built, did not have the pavement of bricks on top, or over the pipes. Some have been laid with only the string courses with mud between. This makes a poor floor as the mud is soon dried and is then cut out and reduced to fine dust. Others have been laid with cement between, instead of stiff mud, with like results. Those who put down this kind of floor, seemed to think a course of brick paving would prevent the floor from heating; this however, is a mistake, for when once heated through, the floor is just as hot with the pavement as without it. We have demonstrated this to our entire satisfaction. We have a steam dryer floor, constructed as the one described, and it gives better satisfaction than any other of the kind of which we have any knowledge. The heat is uniform all over these floors. This makes a good, permanent dry floor and is especially adapted to drying repressed and ornamental bricks or drain tile. We do not desire to be understood as recommending this floor for winter use in severe climates; but for all ordinary spring and fall weather or all sections south of the Ohio River, it

can be used as an all-the-year-round dryer by covering with a suitable shed and close side walls. Should the weather turn suddenly cold and threaten to freeze any wet bricks on the floor, a good plan is to put on a force and hack up the dry brick on the outside walls of the sheds.

Where twenty-five horse power engine is used, the exhaust will heat a floor fifty by one hundred feet, or five thousand feet of surface. On a floor of this size where live steam is used at night, so the floor is not allowed to cool down at night, ten thousand soft mud bricks can be dried every twenty-four hours, or of stiff mud brick set on end fifteen thousand per day can be dried.

Pipes for a floor of this kind and size as described, fitted and put in place, will cost about $800, and requires about thirty-five thousand bricks to complete the floor.

The next question to determine is, does it make back pressure on the engine?

We find that by letting the steam escape freely from the discharging header pipe, the back pressure is hardly perceptible; if however, we fail to do this, the pressure against the engine becomes strong, and impedes it. If the escape is sufficient the only pressure so far as we can see is the friction of the steam passing through the pipes. No more back pressure than in sending steam a hundred yards through a pipe, except that it passes through a series of small pipes, and the combined surface of these is greater than one large pipe, hence more friction.

CHAPTER X.

CHAPTER ON PRESSED OR REPRESSED BRICK.

Does it pay a brickmaker to make repressed brick? This is a question that I am very frequently asked and will answer here as I have frequently done before in person. Experience leads me to believe that there is no money in making a repressed brick on a small yard, or for what might be termed a light market. The principal reason is the light demand for them. Parties buying brick for a house or store building, want the brickmaker to let them have the repressed brick for the front, at common brick prices. This is done sometimes to secure a contract, when there is close competition. This is not only ruinous to the pressed brick business, but tends to a lowering of prices of common brick.

Another great drawback to pressed brick is that they are not properly laid in the wall. There are but few cities in this country that have professional pressed brick layers that make a specialty of their trade and lay nothing but pressed or ornamental brick. The finest pressed brick made anywhere will not look well unless skillfully laid up in the wall.

I think where a brickmaker has a one-machine yard, he should make a good, common brick, handle them carefully, and have kilns that will burn bricks well and of a uniform color. By producing a fine stock or common brick, he needs no pressed brick to effect sales. Where a kiln has pressed brick in it, they are usually in the heart of the kiln. The extra cost of placing

them there before burning, and in getting to them, taking care of them while discharging the kiln, etc., is considerable. When you come to them in kiln, they must be moved away from the common brick and in piling them they must be graded for color. This requires time and delays shipment of the common bricks, however great the hurry to get at them. After pressed brick are taken from the kiln, they should be stored in sheds under a good roof; and where they are to stand any length of time, they should be protected at the sides from dust as it will penetrate several courses into the pile, which detracts very much from their appearance.

Where there is a sufficient demand to justify proper preparation and the clay is suited to their manufacture, there is profit in making pressed brick and ornamental designs to go with them. The clay should be of a good quality and burn a deep red color without any special outside veneer of sand to cover defects in color in the body of the brick; also, that will dry without warping or cracking and remain perfect in shape when ready to set in the kiln. Brick that are crooked when set in the kiln will not be straight when they are burned, and it is folly to go into the market with any other than a first-class A No. 1 brick.

It is necessary to have a fine sand that will burn a red color to match the clay of which the brick are made. This sand is to coat the gluts before repressing. A raw clay finish without sand will not make a first-class repressed brick; fine sand gives them a smooth, finished appearance that cannot be done with clay alone. So we must have good clay, good sand and also a good repress. Lastly, but not least, we must have careful and skillful workmen in every part of the process from the clay bank through all stages of making and burning, and until they are laid in the wall. The question is often asked: "Why do the Philadelphia and Baltimore repressed brick sell for more money in the markets of this country, than those made in other places?" One reason is that they

have a fine quality of clay suitable for their manufacture. There are, however, beds of clay in other places just as good or better, so that this does not altogether account for the superior quality of bricks made at these two places. When we come to investigate the matter, we readily see where the difference comes in. It is in the great care they take in the making and handling of them. They are all made made by hand in a single iron mold, the clay being tempered thoroughly beforehand with tempering wheels, the preparation of the clay being the first important part. They use molds without bottoms, and a fine sand to coat the bricks, which burns as red as the clay. Each time they are handled, they are rubbed with the hand on the sides and ends. The coarse particles that adhere to them are removed with a soft brush before they are repressed. They are handled from the press, and while in the green state, between two thin paddles, and laid with their flat sides upon the floor, and one upon the other until they are five or six deep. In this way the face of the brick, which is the edge, is not damaged by contact. Semi-dry or stiff mud brick may be pressed direct from the machine, as they are then sufficiently dry to be handled from the repress without affecting their shape.

Soft mud brick must be taken from the machine to the yard or drying shed and remain there until partially dry. Just here many have their greatest difficulty, as the brick will dry more rapidly on the surface than inside, especially the angles and corners; and by the time the brick is stiff or dry enough to stand handling, the surface and corners are too hard to repress. What is needed at this point is to equalize the moisture that remains throughout the brick, the center being, as yet, quite damp. This can be done by taking the bricks and setting them in close hacks, using care in the handling of them; then cover with canvass, or old carpets, or sacking that has been moistened. Let them re-

main a few hours and when uncovered, they will be found ready to represss; part of the moisture in the center has come to the surface, and every part is ready for pressure and handling. This is on the principle applied in the laundry of sprinkling and folding of dry clothes to prepare them for ironing. Just why the women folks find it necessary to dry the clothes and then moisten them again, I am not prepared to say. I do know the moisture must be uniform in every part of the brick when it is repressed.

The moulding of fancy or ornamental brick and all repress work is usually done under sheds built expressly for that purpose, and the work should be given to the best brickmakers. The sheds should be arranged so that the drying can be done slowly and regularly. Where the drying is done without fire heat, arrange your roof and racks so as to allow a free admission of both sun and air when it becomes necessary to do so. Battens, or light movable doors, sections of canvass, etc., can be provided to keep off beating rains, or high winds which might cause them to dry too fast, making them crack or warp. In many cases where they dry too quickly, it may be necessary to cover them with canvass or carpet and sprinkle it lightly with water occasionally. When the bricks have dried sufficiently, they are wheeled to the repress only as fast as needed, as they become dry on exposure to the air, or contact with hot floors. We dry our repressed and ornamental brick on a hot floor by setting them on end. To set them on end without injury, they must be pressed quite stiff; stood on end on a hot floor, they will dry in three days. The quicker and safer plan is to place them on edge or on their flat side to dry, as they are not in any great danger of falling over and having the corners broken and marred.

Where the hot floor is not used, they should be placed on smooth pallets to dry. If they are dried on a hot floor they are

taken when sufficiently dry and rubbed with the hand, the corners made free from all roughness and inequalities, and all particles brushed from the face. They are now loaded onto spring barrows with coarse woolen blankets between the tiers; each tier is brushed at the kiln as they are uncovered before setting. If they have been dried on pallets, they remain there in pairs, three pairs to each pallet. We do not use barrows to move our pressed brick to the kiln. The wheelers take two pallets with twelve bricks and carry them to the kiln on their shoulders. The setters take them from the carriers, or wheelers, thus avoiding any chipping of the corners. This care in handling from the glut to kiln is what will give them their square angles and corners; the proper sanding and rubbing, their smooth and velvety appearance, and their color, depends upon their being set right in the kiln and then properly burned, in which line we have had eminent success with our methods. Much depends on the setting of pressed brick; the bottom from which you begin to set pressed brick must be level and each brick set exactly over the one it faces and not projecting sideways or endwise. This requires great care in setting, but is the only way to insure a perfect face on the brick, as there will be a darker line than the body of the brick wherever these projections are made. Set the brick facing each other three courses high, then crossed with three courses again. Twelve courses of pressed brick in the kiln is high enough to set them, and they should be placed at such a heighth as to secure the best results of the burn, and not too near the top so as to have them pale. The blocks on the same level should be reversed, the ends of bricks in one block set against the sides of the bricks in the adjoining block; this is to prevent them from careening while settling. They must be perfectly dry when set, and set on dry brick below them to prevent whitening on the surface when burnt; give them fully as much space between as you do for common brick, as they are harder to burn, being more

dense; do not under any circumstances set them closer together, or the fire will be slow in getting through them and there will be less settle and pale brick where they should most certainly be hard and well colored.

The first thing in order to secure success in making pressed brick, is to have a good supply of clay that is uniform in its quality throughout the bank, that will burn a good red color, free from spots or streaks of black or any other color than red. Then comes a fine quality of sand that will burn red to match the clay. This sand should be prepared by being burnt before using. A good place to burn the sand is to put from two to four inches of it under the green brick in the kiln and burn it with them, and then remove it carefully and sieve it, first through a coarse sieve and on down to a fine one. Before using, it should be run through a haircloth sieve in quantities as needed, and all particles of coarse sand removed. The bulk of burnt sand can be stored in a dry place for use as needed.

Clay for pressed brick is much better to be dug up in the fall and weathered, then hauled into piles convenient for the tempering machine; and this part of the work must be thoroughly done. If it is not tempered sufficiently by one passage through the machine, put it through the second time. After the tempering comes the molding. Some makers of pressed brick, hand-mold all their gluts in steel molds, one or two to the mold. Others use a soft mud machine for their pressed brick and a stiff mud machine for common stock. Again, there are brickmakers who make pressed brick direct from the machine, using a stiff mud glut, and run the clay through the machine twice. They start up and run with fresh dug clay for about an hour, piling the bricks or tempered clay beside the machine; then run this through the machine again, saving the gluts for this day's work of repressing.

I believe the best results are obtained, where speed and economy are expected, by using a soft mud machine, laying the gluts on the floor with a very low heat under them, or in sheds without heat or sunshine until they are set enough to handle without leaving finger-marks on them. Then hack them in piles convenient to be got at with the repress, as the repress is now to be taken to the pile of gluts. One man at the press, with two boys, will constitute a force to make the brick. The gluts are taken singly by a boy, and placed in a tub or box of fine sand, and is turned over in the mass and rubbed until each of the six faces of the cube is thoroughly coated with sand, and is then placed on the table of the machine. The man at the repress must be provided with a can or bucket with oil, and a swab of waste or rags, with which he lightly, but thoroughly, oils all the wearing parts of the repress and the whole inside of the mold, including the lid. This must be done without unnecessary waste of oil or smearing of repress, and must be repeated as often as there is a tendency of the brick clinging to the face of the mold, or to fray or crack the face of the brick as it rises from the mold, or is lifted from it.

The oil used can be crude petroleum of the lighter grades, with enough tallow or cheap fat melted and added, to make it clear the mold freely; or, kerosene oil, with a small proportion of lard oil added—in the proportion of one pint to two gallons of kerosene. The glut is then placed quickly and neatly in the mold-box, and should be thick enough to just more than fill it. The extra clay above the top of the mold is cut away with a wooden blade of hard wood, the lid thrown into position and pressure applied; the brick is now raised from the mold and the off-bearer takes it between two thin, hard wood paddles which can be provided with a light strap to go over the hands, and prevents them from falling and are carried into place on the floor of shed.

There are various ways of drying pressed brick. Some dry

them on end or on their flat sides on a warm floor; others lay them on pallets and place them in racks and dry slowly in the shade; and again others hack them five or six courses high laid flat side down and as close together as can be conveniently handled without coming in contact with the finished brick. Again, I have seen them laid on edge with half inch spaces between them and every alternate course set over the space below. This plan I cannot commend, as the shrinkage of the brick below, with the weight of those above, would cause many of the brick to tear apart to make room for the shrinkage. One thing is very essential, and that is to keep them all about the same distance apart on the drying floor, as the brick will naturally dry faster on the side which is most exposed to the air. This will cause them to draw out of a straight line and be hollow on the side that is dried first, and no matter how dry they eventually become, they remain somewhat crooked. For this reason, I advocate slow drying in the shade. After they are once dry enough to be handled with safety, they can be taken from the floor or hacks, and all particles or crumbs carefully brushed off, and placed in pairs on wooden pallets, three pairs to each pallet, and the pallets hacked up in tiers. These pallets are described elsewhere in this work. In this way the brick are in no danger of being broken on the corners or otherwise marred in handling, and it is also about as expeditious a mode of handling from dryer to kiln as any other.

The making of fancy patterns of brick for cornice, belt courses, columns or door and window-caps, water tables, etc., is becoming an important item in brick manufacture. The designs are numerous and some are very fine, resembling terra-cotta work, and where made to correspond with the square or face brick, they make a beautiful contrast. A front tastefully trimmed with fancy patterns of brick is equal in appearance to terra-cotta trimming. They relieve the monotonous appearance of a plain brick wall and

make a trimming as durable as the wall itself. Ornamental brick, or molded designs are made with the same mold-box and repress, and in this way correspond in size and design with the square bricks, and lay up in bond properly in the wall. The molds or dies are made of brass or iron and are fitted up in patterns to mold the design on the edge or on end as required, and also where a return molding is needed, the patterns are made to mold the design for both edge and end. These designs are made in all the varied forms and devices imaginable, and are susceptible of a multiplicity of designs by different arrangement of the patterns. These patterns or molds are placed in the side or end or bottom of the repress or mold box, and after being pressed and delivered the pattern is carefully removed, which leaves a well defined impression on the brick. These fancy designs sell at from $25.00 to $200.00 per thousand. These brick require great care in the making all through the process, including the setting and burning as well as in shipping. They must be very carefully packed in straw, so as to protect the molding from damage. The greatest expense in the making is the cost of the patterns. When they can be made of iron they do not cost much, while brass patterns cost from $10.00 to $25.00 each and upwards.

These molds after being put in place carefully, care being taken previously to have them thoroughly cleaned and oiled, using every precaution to keep the patterns from striking against each other or any part of the repress. They must not come in contact with any metal or tool of iron to deface any part of the ornamentation. The clay is now forced into the mold and pressed and kneaded down with the hands, and in some patterns pounded in with a light wooden mallet so as to completely fill out the ornamentation of the pattern, the top shaved off as before and pressure applied. The brick is now raised and the pattern is raised with it and must be carefully removed and the brick carried

as before to the drying floor. It is usually best to stand these brick on end to dry on a very smooth, level place. Two men and two boys with one repress can make from two hundred to one thousand fancy bricks per day according to the design, as some require much more time and labor than others, some patterns being in two and some in three parts. This is necessary to remove the pattern without damaging the face of the brick. The clay must be of a plastic nature to receive a well defined impression from the pattern, and must dry without warping or checking. The pattern must be thoroughly cleaned and oiled while in use, and care must be taken to have them thoroughly cleaned and oiled when laid away, for, unless they are smooth and bright, the clay will cling to them and leave flaws in the brick.

The patterns for all the molded brick must be put away in a room or corner of the works that can be shelved off and kept locked up so there is no general handling of patterns by curious, idle persons who will carelessly lay them on the other, or strike them against each other, doing them much damage by handling and examining. These molded brick must be set in the kiln where they will burn hard and uniform in color, set so they will have a good face on the molded side, and to get this they must have a free fire space over the molded edge, and not touch other brick, or they will have fire-marks, and on account of their shape must be set according to the pattern, some on edge, others on the flat side. Square, pressed, or common brick are to surround them and arranged so no weight or pressure comes on them from the brick above. There can be no general rules given for the setting of these brick, as it all depends upon the skill and judgment of the man in charge. Most designs can be set in pairs with their backs together. It requires some considerable practice to set them so as to secure the best results in burning.

This branch of the brickmaking industry should receive more attention from the brick manufacturers, if they wish to compete successfully with stone and iron of all kinds, as well as terra-cotta and encaustic tile. Our people want their homes beautiful and ornamental as well as substantial. This can be done without going outside of a modern brickmakers' supplies, or at least it ought to be. I do not mean by this that every brickmaker should make fancy bricks, as it would not pay to do so. But they should be made by those who are now making bricks in large quantities who have clay adapted to their manufacture, and they should be made in or near all the principal brick markets in our country, so that those desiring them can procure them without paying out a large amount for transportation. It behooves every progressive modern brickmaker to keep up with the demands of the trade and furnish his customers with the best of everything in his line.

CHAPTER XI.

SETTING BRICK IN THE KILN.

All brickmakers recognize the importance of properly burning their wares. This cannot be done, however skillful the burner may be, or how good the kiln, unless the bricks have been properly set in the kiln; and much of the bad burning is due to ignorant or careless setting of the bricks. A slight obstruction will change the course of the heat, it being very sensitive.

In setting brick the spaces left for draft should be uniform, as nearly as practicable throughout the kiln; where they are set three over three, or eight over three, the setter has a guide, and only by carelessness can he go wrong; but in the setting of the benches and overhanging courses, he has no such guide, and must use his skill. Most setters hack the brick in the benches; that is they break joints; this I think is a mistake, as it prevents the heat from moving upward from the benches to the body of the kiln, and all the heat must pass through the overhanging courses to reach the brick in the body of the kiln, and on many yards will be found brick taken from the benches burned and glazed on the ends next to the fire; while on the other end of these same brick there is scarcely a show of fire, as the brick is a very poor grade of salmon; it is so poorly burned because the fire had free escape only at the top of the arch, and was closed in on the sides of the bench, and how many hundreds of such arches can be found with salmon brick through the benches, and the overhanging courses

and two or three courses immediately above them all melted, twisted and tangled up in a mass of ruins. There was an excess of heat wasted on these few brick that would if properly distributed have burned the benches all good hard brick and many more higher up in the kiln.

The benches should always be set so that the fire can pass into them from the arch or fire flue, and from there pass freely upward into the body of the kiln direct. The natural course of heat is upward, and there need be but little fear of these brick at the top of the arch not being burned.

I will illustrate my idea by the following diagram:

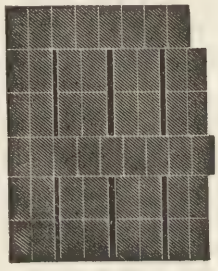


FIG. 3.—ELEVATION.

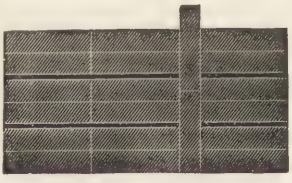


FIG. 1.

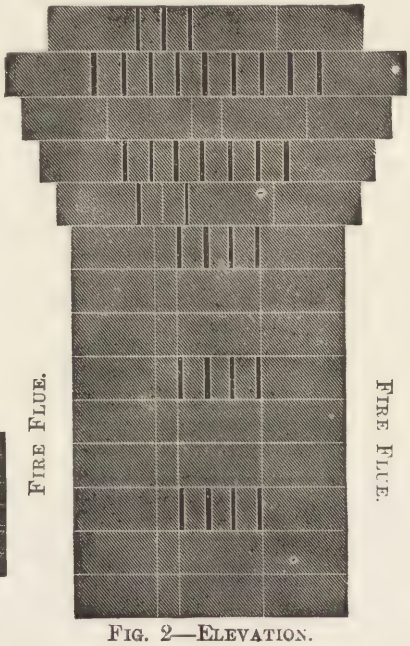


FIG. 2—ELEVATION.

Figure 1 represents the ground plan of the benches between the eyes or arches of kiln. This is a three brick bench, with an

added stretcher course between, known as a three and a third brick bench. The bricks are set in pairs as shown. Figure 2 is the elevation of end view of bench showing stretchers in third, sixth, and ninth courses in middle courses up to overhangers; then each alternate course in middle between the overhangers is a stretcher. Figure 3 is elevation of bench next to fire flue or arch, showing first and second, fourth and fifth courses, set in pairs directly over the other. This shows only six courses. I think it better to set nine straight courses as shown in figure 2. The third, sixth and ninth courses, set tight on face of arch, with stretchers behind them; this crosses the courses and allows a free passage for heat and flame as described, by passing into the benches horizontally, and upward vertically. When the brick are properly set in pairs they have one straight face. The stretchers between the courses, from bottom to top of bench prevent the fire from running from one arch to another, as it will do when one arch is hotter than the one next to it; but it still allows sufficient circulation of heat through the bench. There is in this plan but one tight course above the bench; that is the binding course, which is immediately over the closing courses; one-half resting on each course. This is set tight only on the quarters of the kiln and loose next to the wall for four feet, and through the center of kiln.

I think in setting above the arches, they should be set with a little space for draft next to the wall, and across the end. Set top course same as the balance, and two courses of platting above; the first flat course set crosswise of the top edge course and a full inch between bricks; top platting course to be of good square burned brick, crosswise of bottom platting and close together. The directions refer particularly to coal burning kilns with furnace attachments, but will also be found advantageous in any kind of clamp wall, and I have had good success in burning

with this plan of setting in the old style out door "pile" of bricks with a green brick casing. A good setter with three wheelers will set from fifteen to twenty thousand brick per day. The brick should be set from thirty-six to forty four-courses high. I think forty courses a good height; as high as is convenient to put up, and take down.

In permanent kilns with furnaces attached, I find it best to put a few large pieces of hard wood, or a barrow of coke or coal in the center of each eye, as the arches are set; this expedites the heating of the kiln in the center at the close of sweating, or water-smoking part of the burn.

We desire to impress upon our readers the importance of using good burned brick for platting, and put on as described. It is important for this reason: It enables the burner to economize his heat, as well as to control it, by distributing it evenly throughout the kiln; there are no large holes for heat to escape, or form a draft too strong to control. Many use bats and refuse brick for platting to save a few brick. They save one dollar's worth of brick, and waste five dollar's worth of fuel. There are a great many ways of setting brick; some are good, some are not. We have adopted this plan on account of our uniform success in being able to control our fires with our methods in burning, as well as when we burned in old style kilns, "out door style."

CHAPTER XII.

CLOSING A KILN.

After the kiln of brick is set, then comes the closing up of the doorway to kiln, and making ready to fire. It is a difficult matter to close up the wagon way and make it air tight; however it can be done and very effectually.

With the kiln constructed as is explained in the chapter on kilns, there is, as you will notice, a timber on each side of the doorway, 8x10 inches and anchored to the wall. On the outer corner of these timbers we nail fast with heavy nails, a strip or scantling 2x4 inches on the side next to doorway. This leaves a groove behind it next to wall, and in this is fitted a strong bar of 4x6 inches, to reach across from one timber to the other; three of these bars at each end of the kiln or doorway. These are supported at the end with a short block of wood or scantling, spiked to the timber, and at equal spaces between top and bottom. These bars serve as a brace or bar, against which the closing wall is to receive support.

The closing wall is a nine inch wall of brick hacked up against the unburned brick. Then give it a coat of daubing mortar, made of three parts of loamy sand, and one part of soil or clay; there is a great mistake made by most all hands on brick yards, in this matter of daubing; the mortar should be nearly all sand, and then it will not crack. I have seen kilns daubed all over with a pure clay mortar, laid on while the kiln was warming up and the daub

was more of a hindrance in several ways than it was good. It certainly could not keep the air from penetrating the kiln as there was not a patch of daub on the whole outside of the kiln, of the size of a man's hand that was whole and free of cracks. Try this daub made of loamy sand alone, and then close beside it of half clay, half sand, or another of all clay and note the difference. The daub is made to stop up cracks and openings on the outside of kiln, and if it does not do it, it is of no consequence.

Outside of this closing wall, put up another wall, leaving about four inches of space between them; fill this space with fine sand being careful not to pack it, but shovel it in loose so it can settle when the kiln gets hot and shrinkage begins. The outside closing wall must be well braced against the bars; sufficiently so as to stand the push of the hot kiln and all the weight of brick and sand behind it.

This is a very important piece of work and must be carefully done; so it will not fall down while the kiln is hot, or so the sand will leak out, or run in among the burning brick, and choke that end of the kiln. As your kiln shrinks and settles in, the sand will settle at the top and must be kept filled up as high as the top of the wall. Keep the air from entering, for air will make salmon brick all over the space which is effected by the draft, driving the heat farther in from the wall, and when all the balance of the kiln has settled, this place would remain high and be unburned. When done burning the kiln, this closing sand if it is of a suitable kind, will answer for sanding molds on soft mud machine, or any other such use as may be desired, or it can be saved and piled up at the end of the kiln, in a box or bin, and used for the same purpose next burn.

Kilns that are built twelve or thirteen feet high on side walls, are not high enough to come to the top of the unburned brick when they are set forty courses or more in height. It is always

best to set above the top of the wall enough to allow for all the settle of kiln in burning to still remain above the wall.

This unfinished part of the kiln, is now built up with a loose nine inch wall of brick all around, with the inside end of the bricks plumb with the face of kiln wall, and built up to a level of top of green brick. Let it be carefully daubed from the wall to top of hack. During the burn and after the kiln begins to shrink, or kiln walls expand, keep the top of this loose wall pushed in close up to the brick, to prevent a too rapid escape of heat next to wall, or flame from rushing out and endangering the frame work of roof; by pushing this wall up tight and close, the platting is tightened on the heads and quarter, driving the draft to the center of kiln. Keep a good supply of daub, on hand after the kiln is fired. Do not put off the necessary closing up until after the fires are lighted, as something will be likely to be neglected. See that the end walls are all properly closed, false wall up and daubed, platting all nicely adjusted with a uniform draft over the whole top; all openings about the kiln closed, and cracks all daubed about kiln, wall and furnaces, except the fire door of furnace Then you are ready to light the fires in your kiln, providing you have fuel enough convenient to burn the kiln. Always, if possible, have the fuel on ground before you set fire to the kiln, as there must be no let up of firing from start to finish.

CHAPTER XIII.

BURNING A KILN OF BRICKS.

The first thing to be taken into consideration when the fire is first lighted under a kiln of brick, is the condition of the brick when they were set in the kiln. If they have been set in "bone dry," they will stand a good, strong fire on the start, and will not be long in water-smoking. If, however, they have been set only partially dry, the fire should merely be kept going, or a slow, smoldering fire for the first twenty-four or thirty-six hours, after which, increase the fire gradually. Care is required in this part of the process of burning, particularly if your brick are damp. If the brick are "bone dry" and everything is favorable, they will water-smoke in forty-eight hours. Should they be quite damp in any part of the kiln, it may require four days, or even longer, to dry them without crushing or whitewashing the bricks. There should never be red heat in the kiln while water-smoking.

Many years' experience teaches me that whitewashing of bricks in burning is caused by making the kiln too hot in the arches while water-smoking, and there is danger of crushing those higher up in the kiln with the weight of those above them, as the vapor in its passage through the kiln softens those at the top; our advice is, "Go slow" in water-smoking and do not have a water settle, as that is a most unwelcome sight to a burner, for he knows what it means; and to one who has not seen one, it

can only be conjectured as to the difficulty he will have to burn such a mass of debris.

I have burned bricks made from stiff clay, some of which were set only partially dry. Those that were "bone dry," were smaller than the others as they had shrunk all they would in drying, while the others had not; the consequence was, where we set damp bricks, the kiln was three or four inches higher than the rest; when these began to dry the top began to sink and when we were done water-smoking, the kiln was level and the bricks uninjured. This could only occur with stiff clay bricks and very slow fires, and then, perhaps, only in certain kinds of clay. I do not think that bricks are ever injured by slow drying, and they are by a too rapid fire on the start. When the bricks are set quite damp, I think it is well to let the fire go down low occasionally, which will drive the heat to the top of the kiln. Some burners even put a fire in the arches or furnaces at a late hour at night, and let it go till early next morning. This is, in my opinion, a poor plan. I prefer to have a watch with the kiln, even if he does little or nothing, to see that no accident occurs or be on hand in case of wind, rain or freeze, or any other untoward circumstance.

In water-smoking or sweating a kiln, either wood or coke should be used for red brick or terra-cotta ware. Fire bricks can be water-smoked with coal fires as a start, if they are set dry enough so that soot will not adhere to them so as to impede the draft.

The question is asked: "Which is the cheapest, wood or coke; and which is the best?" This will depend upon the place you are situated, and the price of wood and coke. Coke is the best for the reason that there is no smoke or soot, and is a steady, pure heat and your fire is very regular. One man can water-smoke two or three kilns at the same time and then not be over-worked, where everything is conveniently arranged. I consider coke the

cheapest when it costs not more than 12½ cents per bushel, and wood is $2.00 per cord. The cost is nearly equal, but the coke is the best, as it requires more labor to water-smoke with wood. If you have anthracite coal as fuel to burn brick, it is not necessary to have either wood or coke, except to start the fires in the furnaces.

You leave the furnace doors open in water-smoking, except when the kiln begins to get dry and hot on top, say the last twenty or twenty-four hours, then close the doors and let the heat be increased gradually without making the arches red hot.

After the fires are lighted in the furnaces, it is necessary to set up six or eight rows of platting lengthwise of the kiln and occupy the central half of the kiln. This is to make draft to the center, and to allow water-smoke to escape freely; as fast as the bricks on top become dry and hot, close them down.

A kiln is not always dry when the vapor cannot be seen. In cool weather it shows plainly, or at night or early morning when the atmosphere is charged with moisture; then it shows very plainly, but in warm weather, especially in the day time, it cannot be seen. The only sure test, is to drop or sprinkle water lightly over the top course of platting, and if the bricks are dry and hot, they will hiss or send forth a "soda-water sizz," and show that there is no water-smoke in that place.

In water-smoking, sometimes heat leaves a certain part of the kiln; then we have a "cold spot." In this case I put down all the platting that have been raised on that part of the kiln, and make the top tight, to prevent the escape of the heat and prevent the cold air from going down from the top.

The heat being generated faster than it escapes, soon spreads to every part of the top of the kiln seeking an outlet. As soon as the cold spot is thoroughly warmed up in this way, open the platting there and the heat will rush there, because of the strong

draft, and soon warm up and dry out that part of the kiln. It is a matter of great importance know how to remedy a "cold spot," either in water-smoking or raising heat.

In burning with coal, or coal slack, it is important to have the kiln dry before beginning to fire with it; for wherever there is any dampness, there the soot will adhere, and retard the draft, and heat will be slow in that place, the soot remaining on the brick until driven off by red heat. When this mistake has been made the surest and quickest remedy is to cease firing with coal, and fire with wood or coke until the soot is driven out; then put on the coal again.

In kilns with furnace attachments, nut coal or coal screenings, is the best fuel. It is much better than lump coal, as it saves the labor of breaking the lumps; it can be distributed evenly over the the grate bars, covering every part of the furnace floor, and can be fired quicker; the furnace doors are not required to be kept open any length of time to admit a large volume of cold air. A good fuel is two parts of nut coal and one of slack, providing it is free of dirt and slate, and is fresh from the mine.

Where your fuel is full of dirt or any deleterious substance, the intense heat will melt it along with the ashes, into a clinker, or cinder on the grate bars, which will give the firemen much trouble; as he must have draft from the ash pit, through the fuel to have perfect combustion, and make heat.

When clinkers forms on the bars, removing them will cause a loss of heat in the kiln, consequently an increase of the fuel bill, and we would urge it upon you to see to it that you have good fuel always, whether you use wood or coal. The cost may be a few dimes more per ton. The place to count the cost is to count the result, when done burning.

When the kiln is dry, put on coal and increase the heat, bringing the arches to a red heat as fast as possible. As soon as

they are heated their whole length, increase the heat again, until they are a bright red or near the point of settling; then hold the heat steadily at this point until the fire appears all over the top of the kiln, and is as hot on top, as in the arches. Then put on the settling heat, and when the top begins to sink, see that it sinks uniformly. If one part settles faster, fire under that part less, and under the high part more.

It is important to keep the casing jammed close in against the burning kiln; also to tighten the platting where it opens; flame should not appear above a finger length on top; should it appear in greater length or size, the heat is then being wasted and the brick will not burn close to the top.

Bricks that are set forty courses high, should settle all the way from six to eighteen inches according to kind of clay used. I speak now of those clays that are more generally used for making building brick; as there are some clays with which we have had to do that did not settle any, and instead of settling, actually raised up two inches higher; in this case our guage would have to be the swell rather than the shrinkage. The only certain way to determine the amount of settle required is by a practical test.

In testing a new clay, or rather burning a strange clay for the first time, I always watch the arches very closely, and as long as they stand up straight, and show no sign of melting, I feel easy about those above. To settle a kiln on the heads that is next to the walls, fire light and often. To throw heat to the center, fire heavier with longer intervals; as the fire burns low, the draft which all comes in at the sides drives the body of heat to the center of kiln. I always find it best to settle the whole of the kiln together, keeping the top all over as level as possible.

A kiln should be from forty-eight to seventy-two hours in settling. I think three or four inches in each twelve hours is as fast as clay can be settled, without breaking or warping the bricks, if

your clay is one that shrinks in burning. It is well known that there cannot be a good burn without the required amount of settle. But there may be the required amount of settle and not a good burn. There are two kinds of settle, a true settle and a false settle. The true settle is when the shrinkage of the brick is uniform from bottom to top of kiln, as near as practicable, while the latter is nearly all in the arches or bottom of kiln. This is caused by firing too hard before the heat has time to equalize throughout the kiln, and pass up to the top courses. It is to lead burners to avoid this that I have explained how, in my opinion and experience, it can be accomplished.

The burning of bricks is certainly the most important part of their manufacture; unless they are well burned all previous labor on them is lost. They may be perfect in shape and finish but almost worthless if not properly burned. The money is made or lost at this stage of the process. I think there have been more failures on account of unsuccessful burning than from all other causes; hence anyone embarking in the manufacture of bricks who has no practical experience, should, by all means, secure the services of a competent burner; make a success of this department, and I have no fears but that the difficulties of "making" can soon be overcome.

One thing essential to good burning is good setting. Bricks must be set in the kiln properly, or the burner cannot burn uniformly. The spaces between the bricks should be uniform all over the kiln. There should be at least a half inch space between the bricks in all parts of the kiln. And in setting the benches and overhangers, or projecting courses in arches, care should be taken to allow space for heat to rise freely to the body of the kiln, through the overhangers as well as in the benches.

After a kiln of bricks has been burned and closed up, it has then to be cooled ready for delivery; and usually the brickmaker

is in a hurry to get his kiln opened. This hurry many times causes brick to be seriously injured after they are burned. A too free admission of air while the bricks are hot will discolor them. Some clays that burn a light red, will have a pale salmon color, caused by the moisture in the atmosphere, coming in contact with the hot surface of the brick. The cold air causes the brick to cool too rapidly and cracks them. All clay products are fragile and will not stand rapid cooling. It is well known that glass will fly into fragments, if while it is heated it is brought into contact with a draught of cold air. Now brick partake, in a measure, of the nature of glass; and if it is cracked or shattered in the process of cooling, the brick loses its metallic ring and its strength is impaired as a building material; thus detracting from its market value.

As a rule, tough, tenacious, plastic clay, can be cooled faster without injury, than free, sandy or loamy clay.

Large kilns with heavy walls, should have from three to five days to cool; according to the nature of the clay. And they should not be made air-tight below when closed; there should be small openings left in each furnace low down in the closing of the ash-pit, to admit some air below to supply the place of the hot air escaping at the top of the kiln. If a kiln is made practically air-tight below, when closed, cold air will enter at the top to replace the escaping heat; this will cause the top courses to be brittle, where the cold air goes down. A few inches of air admitted below will prevent this and not damage the most tender clay. This I learned by observing the top of cooling kilns at night.

When you are hurried to get a kiln cool, after it has been closed twelve hours, admit a little more air at each furnace, and keep enlarging the opening two or three times in each twenty-four hours, until you have the door fully opened at the end of the second or third day. In this way it cools gradually though rapidly.

You can soon determine just how fast you can cool your kiln without damaging your ware, and then act accordingly

The general color of all burnt brick is red or some shade of red; owing to the clay containing a greater or less per cent. of iron. Where the percentage of iron in clay is large, the brick are apt to be blue; in particular if the degree of heat comes near the melting point, and is then subjected to a volume of fresh or cold air. In burning bricks we have to give them the utmost care and attention, so as to bring them as near as possible to the melting point without endangering their quality.

I am frequently asked my opinion as to which is the best in burning bricks, to give them a good color—a dead heat or a lively heat? I am always in favor of a lively moving, heat, and I desire to be fully understood. I base my opinion on practical experience through a long term of years, although it may be unscientific.

My experience has been that when a kiln had tardy draft, the heat remained too much in the arches and bottom of kiln; and the result was the arches were more or less melted, and several courses of salmon or pale bricks on top, and three or four days extra time consumed in burning.

Where there was proper draft, and moving heat, the burn was nearly uniform from bottom to top, and the color of the bricks the same, with a much better and brighter color than those burned with a dead heat.

The latter are really baked, instead of burned.

Another important item in burning bricks is to burn them well with economy of heat. This includes proper combustion, as well as thoroughly utilizing the products of the same afterwards. We may have a furnace with heat chambers and all that, producing as near as practicable, perfect combustion and then waste the heat afterwards.

First, we want a heat generating furnace of proper dimensions and with sufficient grate surface; and grates with air spaces, according to kind of fuel used.

Then we must have heavy, close built walls, to prevent radiation of heat, as well as to exclude cold air.

Then the top of the kiln must be so arranged as to allow only enough heat to escape to make necessary draft and no more. Some draft is necessary to produce perfect combustion and equalize the heat throughout the kiln from side to side and from bottom to top. All these things are indispensable to economy of heat.

Then there must be skill and judgment, and close application of the same, to properly manage the firing and regulation of heat. This must not be left to boys or unskillful men. I do not want a kiln that "any boy can manage." When a manufacturer has one, two, or three thousand dollars worth of bricks dependent upon the result of a single burn, he wants a man of skill and judgment, and one reliable in every way to look after it. If the ware or any part of it is spoiled or even in part damaged in burning, it is a loss of labor from the clay bank to the finished product.

In using bituminous coal it is necessary to have grates upon which to burn it. In using coal screenings, I think grates with half-inch slots about the proper air space, with a thickness of bar of three-quarters of an inch between slots. I find a grate surface of about twelve square feet, the best for each furnace.

There are two advantages, or rather objects, in view in having furnace attachments to clamp walls. First, to have as near as practical, perfect combustion, thereby economizing all the heat contained in the fuel; and again, to exclude all the cold air from the ware in the bottom of the kiln, and avoid subjecting the same to every sudden change of temperature, thereby

keeping a uniform heat in the bottom of the kiln as well as in other parts of it.

While I believe in applying scientific knowledge in every way it can be done, to the making and burning of bricks, I think, at the same time, bricks cannot be burned by rule; neither can any arbitrary rule be applied to the economic use of fuel; conditions and circumstances, quality of fuel and quality of clay, are so varied, that rules must be flexible indeed to cover every case. Some fuel requires more under-draft through the grate bars than others; and, again, some require more air above the grates, and then different stages of a burning kiln require different applications of air in place and quantity.

I am satisfied air, in proper quantity, should be admitted above the burning fuel or grates; then after the gases are superheated in their passage through the heat chambers, then near where the heat enters the kiln proper, there should be admitted as much oxygen as the heated air will absorb without reducing the heat below the degree required for the burning of the ware. This can be regulated by admitting more or less air and a careful observation of the heat in the arches. One skilled in burning wares knows at a glance whether he has the proper degree of heat or not. Coal must have a certain amount of air passing through it from below, in order to insure a high degree of heat. Wood will burn without so much under draft. A pile of wood will burn with a fierce heat even on the ground outside, while a pile of coal would only be a smoldering fire unless blast is applied.

It is always well to admit some air above the fuel on the grates, anywhere between the grates and the kiln. This is done in a number of kilns with more or less success.

There are some writers on brick burning who claim a great loss of heat in an updraft open-top kiln. I cannot accept their assertions as true. If escaping heat is referred to, I agree; for it

all escapes, every particle of it; we have no use for it after it has passed the ware, unless we can utilize it in some other direction; escaping heat might be, and is, I believe, used for drying purposes; but it is useless for burning.

Escape of heat is essential to practical burning. Bricks can no more be burned with a dead inactive heat, than a fish can live in stagnant water. It is a law of nature that action is necessary to life; stagnation in anything means death and decay.

To burn bricks properly the heat must be kept uniform in every part of the kiln; to do this there must be draft which means moving, lively heat; we cannot have draft without escape. "The mill will never grind with the water that has passed," so it is with the kiln fire.

The amount of fuel cast into the furnace at each recurring fire is another important item. Only enough should be thrown in at each firing to make a light coating all over the grate surface; say four or five dirt shovels full; the thickness of burning coke on the grates, should not exceed four or five inches, and the grates kept clean so as to show a bright light in the ash-pit at all times; and to save your grate bars, hot coals and ashes should never be allowed to accumulate in the ash-pit.

Now, it seems to me, after the proper amount of air has been admitted above and below the grates in the furnace, (the amount admitted below is regulated by the size of the ash-pit door), then again near the point of contact with the ware, admit just as much as it will bear, we have then done all that can be done in this direction—the amount to be determined by the burner and adjusted to suit the quality of the fuel and the condition of the kiln at the different stages of burning. Again, the top of the kiln must be so arranged that the escaping heat can be reduced to the lowest point consistent with draft required; there should be more space for heat to escape while water-smoking, than when you are raising

heat or settling a kiln, as the draft is less strong at first, for the reason that the bricks are cold and damp, and the heated air in its upward passage through the kiln becomes heavily surcharged with vapor, which is heavier than air. And here the judgment of the burner must be exercised. If you are starting in the early spring, and it is your first burn after your kilns have stood all winter, allowance must be made for dampness in the walls and floor. "Go slow." Take time to water-smoke, make a good burn on the first kiln of bricks, even if it consumes a little more fuel, time and labor; and you can undoubtedly shorten the time on the next burn; but never do so at a risk of damage to your brick or tile. Keep up a slow fire the first twenty-four or thirty-six hours, and as the bricks begin to get dry below and warm up above, the draft becomes stronger, and the kiln wall begins to expand, then all the open spaces on top must be reduced. This can be accomplished very readily by pushing in the casing above the top of the kiln wall, and the platting that has been raised dropped back into place.

Another plan is to lay the top platting with a space between them; then when ready to tighten up, they are forced together with a spade, and other bricks put in the spaces. I prefer the former plan, as it is less work to close up the top, and the heat is always under better control.

After a kiln is heated to the top, the object then is to let the heat out of the arches as freely as possible, and hold it closely at the top. In this way the arches are not too hard nor the top brick too soft. The heat can be driven out of the arches to the top by throwing air currents at a moderate degree of heat into them, and thus prevent overburning or melting of the benches below. This is our method and one with which we have had a marked degree of success.

CHAPTER XIV.

BRICK BURNING AND KILNS.

This department of brick manufacture, is constantly coming to the front, as the key to the situation. This is the point where the most enthusiastic would-be brickmakers have met their Waterloo, and this is the rock that will wreck many another unwary mariner on the muddy seas of brickmaking.

There is nothing that makes me so "utterly tired," as to hear one of these alleged brickmakers tell how he burned a kiln in two days and four nights, with just half the amount of fuel that any man had ever used before. It is true that there is a vast difference in clays; some requiring more fuel, as well as more time to burn them.

The time it takes to burn a kiln of brick is an insignificant item; and the amount of fuel used, is a matter of secondary importance. The great objective point is to make a good burn; that is ninety per cent. and upwards of hard bricks, with ninety-nine to one hundred per cent. of the bricks burned, fit for market. Do this *every time*, and nine cases out of ten you will succeed as a brickmaker.

The ruinous policy of sacrificing the quality of the brick as well as destroying a large percentage of them to save a few tons or cords of fuel, and a few hours, or even days of time, is followed by some manufacturers, and they will persist in it until they fail miserably. I have known instances where manufacturers of brick, com-

pelled their burners to burn their kilns within a given time; and to do this melted the arch brick to get the required settle, and left many thousands soft in the top courses; this to humor an absurd whim.

Some of the best processes of burning are condemned by many brickmakers because they require forty-eight hours more time to burn than the process they are using; even though in the end there is a considerable saving in labor and fuel, and a decided improvement in the product.

I believe in using a kiln that insures the manufacturer a well burned kiln of brick *every time;* even though it requires more time and more fuel.

A New York merchant can send a cargo of goods to a foreign port, cheaper than his competitor can, by sending them at his own risk; thereby saving insurance premiums that others pay. Would he display business sagacity and foresight by this scheme? Is it not best to pay more money, and make his profits secure? There is just as much sense in trying to save insurance premiums on goods shipped by an ocean steamer, as there is in using a kiln that saves a little time and labor, and risk having a poor burn.

Use a kiln that carries assurance with it, one that will bring forth good fruit every burn, to the satisfaction and profit of the owner.

It is not the intention of the writer to condemn a kiln that burns with little fuel and short time, provided it does its work well, turning out good brick with little or no waste. I only wish to show the folly of trying to gain time and save fuel at the sacrifice of good results.

I must add however, that when we have secured a good kiln, it is then necessary to secure the services of a successful burner. We have not reached that golden era in our business where we can burn a kiln by "printed rules," only requiring a man of muscle,

with sufficient education to read the rules, to make a perfect burn every time. When this is done then any one can take his chemicals, brushes, canvass, and his *printed* rules, and paint pictures that will rival those of the immortal Raphael, or Michæl Angelo; or with mallet and chisel carve from a block of marble the "Three Graces."

Which process of burning brick will insure the most successful and economical results taking all things into account? Does it pay to have permanent walls to burn in? Or, shall I burn with the old fashioned casing or scoving kiln, which is a nine inch wall put up around a green kiln, and taken down after each burn? The old style casing kiln has many objections. First, the labor of building up and taking down the casing at every burn.

Again, the walls being light and illy built, there is a great deal of cold air enters the kiln all over the outside wall which deflects the heat towards the center, and the fire cannot be controlled; hence there is a large per cent. of salmon brick all over the outside and more particularly on the ends and in the corners. The fuel being burned in the arches directly under and in contact with the brick, melts a great many. The coals and ashes, which accumulate while burning, prevent a great many in the lower part of the benches from burning hard enough. Then, too, the fire holes of the kiln are open whenever the fires burn low, and the draft of cold air comes in direct contact with the heated arches, while the brick is thus expanded with the heat, and is exposed to a draft of cold air, contraction takes place instantly, and the brick is checked, split, cracked, and in some clays, broken entirely off.

The old way of burning is always a much more laborious way of working; there is no certainty of the result, and among the many scores of brick yards we have visited, we have found but few who practiced any well established method who worked on the old plan.

One plan with no other object in view than not to burn over six days was to hurry the matter all it was possible and shorten the time of the burn from six to five or even four days, which is followed in some places yet, with very poor results; as it is impossible entirely, to burn brick properly in that time, and make a success of the burn. Our advice is to go slow on the first two-thirds of the burn, and get your heat well up all over the kiln. Don't get in a hurry, on the water-smoking or in raising heat; take time to do the work well, even if it takes eight or ten days. The question of what process of burning to adopt, or what kind, or class of kilns to use is one that should be well considered, for this point, after all, determines whether the enterprise is a success or failure, as bricks have but little or no value in the market, unless properly burned.

To burn a kiln of brick it is necessary to have a wall or casing. The first question arises whether it is best to burn in a a temporary wall; that is, shall we build a light wall and remove it when done burning, or shall the wall be made heavier and more durable, and be permanent, so that we can use it for one, two or five years without rebuilding.

There is only one advantage that be can claimed in favor of a temporary wall, and that is after removing the wall the convenience of getting to the burnt bricks at all points. In every other respect, the permanent wall is better and where permanent kiln walls are built with rail road tracks at each end, and the bricks loaded on cars instead of wagons or carts, it is just as cheap to load from a permanent clamp. While the saving of expense in building the temporary wall, and removing it after each burn, together with its attendant waste of bricks, soon amounts to enough to build a good, heavy kiln wall. Again, with a heavy wall, the bricks can be burned hard closer to the sides with less fuel, and is less affected with the wind or weather.

A permanent wall, however, does not prevent waste in burning. The arch bricks are melted, twisted, cracked, or broken with intense heat, and drafts of cold air, the same as in temporary walls. To avoid this waste, furnaces are attached to these walls, and cold air is kept from coming in contact with bricks in the bottom of the kiln; the heat supply being continuous and regular so that the arch bricks are not melted by sudden, intense heat, or broken by sudden contraction caused by cold air rushing into the kiln when the fire door is opened. In this way the arch bricks are saved whole and sound, and well burned to the ground, there being no bed of coals and ashes there to prevent a free circulation of fire and heat among the ground courses.

Another advantage of furnace kilns, is they burn coal screenings, which in most places is a very cheap fuel and will burn equally well with wood, lump coal, or run of mine, and with less than half the labor required to burn a kiln of bricks on the old fashioned plan; as one man on each watch can do all the firing for a kiln of two hundred thousand or more.

For the first kiln of this class, brick manufacturers are indebted to the inventive genius of E. V. Wingard. His invention amounted to almost a revolution in brick burning, as his process used a refuse fuel, the coal screenings of the coal mines, at less than half the labor required in the old way, and burned a large per cent. of good brick with a very small waste in the arches, and did this with a kiln that was not complicated in its construction and management. The name of Wingard will be, as it is now, familiar to brickmakers for many years to come.

This invention like many others had some weak points or imperfections. Few new inventions have had so many good points and so few defects. There have been a number of improvements made on this kiln, which have added a great deal to its strength and durability, as well as simplifying and perfecting the methods

of controlling and regulating the heat, and giving more perfect combustion of the fuel.

There are perhaps less than six other kilns of this class, that are in general use and practically successful. This class of kilns, I consider the best for burning common building brick, as they are comparatively the cheapest kiln to build, and do good work economically, and are not limited as to capacity. They can be built to hold one hundred thousand, or one million, and still be complete in every part, and the best evidence that they are well adapted to the use of the brickmaker, is the fact that they are found in successful operation on most of the principal brick yards in this country. This cannot be said of any other class of kilns.

As I have remarked elsewhere in this work about machines, go and see these different kilns in operation, on the yards where they are used. If possible, see them in different stages of the burn, note the amount of labor and class, and amount of fuel. Examine the kiln in all its particulars, from the filling with green brick to the discharging its burned ware. Examine closely the results, and then determine which of these is best adapted to your situation, clay and circumstances. If an inventor has a good kiln, dryer, or machine, he is not afraid to have its merits investigated, and the only way to do this is to see it doing the work required of it. Bear in mind that a brick kiln is an invention that cannot be carried about and demonstrated as a success, like a corn planter, pencil sharpener, or sewing machine. You must either accept the testimonials of its patrons, or go in person and see the kiln in use.

The brickmaker who spends a few dollars traveling among the principal brickyards within three or four hundred miles of him, examining into the different methods of manufacture and burning, will not be the loser in any sense, and his investment in that respect will be returned to him in dollars many fold over,

by his coming in contact with and adopting other labor, and money-saving devices, as there is no one yard that has a monopoly of all the good things, and but few yards but possess something of value to the man who is willing to learn, and is on the search for a better plan.

The next class of kilns to which we wish to call attention is the down draft kiln. These are built both square and round, with an arch or crown over them. This crown has several small holes, of six or eight inches diameter in it which serves as a vent for the vapor, and to make upward draft in the early stage of the firing; these holes are usually shut down after the kiln is heated throughout, and the smoke and flame are carried out at the bottom of kiln by a subterranean flue which is connected with a high stack and controlled with a damper in same. These kilns are built with a capacity of from fifteen to fifty thousand fire bricks, and for burning these bricks, sewer pipe, etc., are as good and in some respects better than the up draft furnace kilns. They are however, in proportion to their capacity, much more expensive than the up draft kiln, and are beyond the reach of the common brick manufacturers, and also too small to be made available on yards with large capacity. One of the difficulties of a crown kiln is to properly support the arch so that it will not settle, and eventually fall in. Another objection is that the kilns are not so easily filled and emptied, the arch being in the way. But they save the trouble of platting the kiln.

Another class of kilns which is a modification of the direct down draft, is the up and down draft. In this kiln the fire is carried up from the fire box, or furnace, with a flue or flues, on different sides of the kiln, and the heat is radiated through the sides of the flues and the volume of heat and flame carried up through them and then downwards to the subterranean flue as in the kiln mentioned before. This kiln is much more successful than the

direct down draft; particularly for burning tile, sewer pipe, terra cotta, pottery and such ware. It is also used on many fire brick works, with eminent success, where there is no great capacity required, as is the case on yards making building brick.

There are also continuous kilns, for burning bricks which are in use to a very limited extent in some parts of the country. These kilns are built in different shapes, according to the pattern or design of the different patentees. Some are circular, others are oval; again, they are built in the form of a parallelogram, and are subdivided into a series of arched chambers, with a capacity usually of from eighteen to twenty-five thousand to each chamber. These chambers are built so that they are connected one with the other, so as to form a complete circuit, and are in size so that there is from twelve to eighteen chambers thus connected. These chambers are each connected with a high stack, and provided with a damper, the object of which is to close off any escaping heat after the bricks are dry in that particular chamber, and send the heat through the next succeeding chamber or kiln. A plan adopted by some is to close the openings from one chamber to the next, when the kiln is being set with green brick, by putting over the opening a large sheet of cardboard, and as the heat rises this is burned away, and escapes into the adjoining kiln, and the damper is now closed to the stack from the dry kiln. The heat is raised to the point required to burn hard the brick that are behind, and each day is expected to burn off a section, empty a section, and fill another with from four to six sections intervening between the kiln just closed and the one just filled; not less than three sections cooling; four would be better, particularly if the capacity of the chambers are large.

The mode of firing this class of kilns is peculiar, inasmuch as the fuel, which is coal, is dropped in among the brick through an aperture in the crown of the chamber, and is scattered among

the bricks in its descent to the bottom of a flue, which is built among the green brick as they are being set. The work of firing is a very light duty, as the charge of coal is scarcely ever more than from three to five pounds at a time. What is required in this is skill in burning. and the man in charge as burner finishes one chamber and then an assistant must take the night turn, and another is finished by the head man next day; this continues daily without interruption. These kilns, as is well known, are expensive to construct, and so far as my observation goes, have not been made a practical success in this country. The reason perhaps lies in the fact, that they have not been properly constructed on account of their heavy cost, and probably not well managed in burning them, through ignorance of the method. In Germany they burn brick successfully in the Hoffman Kiln, which is the representative kiln of this class. The great merit of these kilns is their saving of fuel; but our brick manufacturers in this country, with the exception of a few, are not prepared to build such expensive kilns.

There is occasionally an inquirer who writes to some of the brick or clay journals, asking if brick and tile can be burned together in same kilns; or in other words, can they be manufactured together with profit? Where the clay is adapted to both brick and tile, I see no good reason why they may not. There are a number of machines that will make both bricks and tile, by simply changing the dies. They can be dried by natural and artificial heat, and there is no question about burning them together, having burned them together for five years. I used a Wingard Kiln, 24x16 feet inside; set the arches with bricks, and set fourteen courses of bricks in the bottom, then ten courses or tiers of tile on the bricks. In this manner, the kiln held twenty-seven thousand bricks, and thirty thousand three inch tile, or twenty thousand four inch tile. I used two hundred bushels of coke to water-smoke a kiln, and

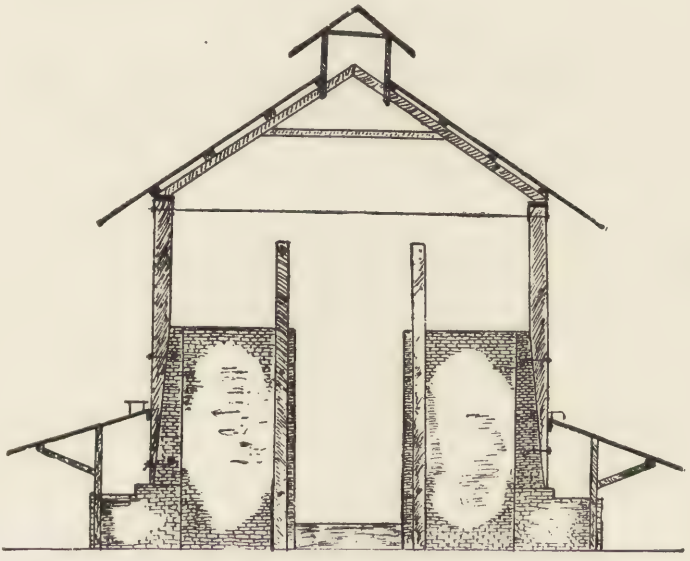
from thirty to thirty-five tons of coal screenings for burning. The bricks were all good fronts and pavers, and no waste, while the tile were well burned, and usually the waste tile did not exceed one per cent. This kiln could be used for bricks alone, and would hold about ninety thousand when set forty-four courses high.

I have seen kilns of this kind filled entirely with tile, forming arches with tile, with comparatively little loss in the arches. Where a kiln will burn either, or both together successfully, there are many advantages in making both bricks and tile. When the demand for one is light, make the other, and vice versa. There are places where the demand for bricks does not justify a man in giving his time to brickmaking exclusively, and the same with tile; when perhaps the two combined would make a fair amount of business, and yet the demand for both would not warrant a man in having a machine for brick and another for tile. We have seen the same thing occur in the pottery business, where the works if confined to pottery alone, would have had a very meager trade, but were situated so favorably in respect to clay, market, etc., that they made in addition to the above, sewer pipe and fire bricks also. This kept the force always employed and established a good trade.

The most important thing about starting a tile works, is to secure a good kiln, and a burner who will burn the tiles hard, and do this with small waste. I spoke before of using the Wingard Kiln. I do not say that is the kiln you must get, or must not. There are other kilns of more recent design, and later improvements. That is a matter that is left for you to decide and adopt as your choice among the many.

After all, brick manufacturers in most sections must depend on wood or coal for fuel, and the kiln that burns this fuel most economically, and produces the best results, is the kiln wanted by a great majority of the brickmakers.

In building a permanent kiln of any kind the walls should be at least thirty-two inches thick at the base, and sixteen at the top, and lined with fire bricks, where exposed to intense heat; all brick work of the whole kiln to be bonded together in the best manner known to the brick layer, as the intense heat to which it is to be subjected, tends to destroy the wall, even when built in the very best manner. A good kiln properly built and managed will soon save every dollar of its cost, and do good work for many years, with occasional slight repairs.



IMPROVED BRICK KILN AND ROOF.

A permanent kiln should have a permanent roof; that is, a roof that need not be removed when burning. Such a roof should be at least nine feet above the top of the kiln; that is to say the plate or eave should be that height. It should have an opening or ventilator at the peak of the roof, four feet wide; this ventilator

can be raised three feet above the main roof and covered with roof boards similar to the covering of the kiln. The timbers supporting the roof should be at least 6x10 inches with the six inch side against the wall; they should be firmly bolted to the wall with anchor bolts, that fasten to a rod running through the main wall. The plate on top of these posts should be 4x10 inches and fastened to the posts with a flat bar of iron ½x2 inches, and three feet long, bent so as to lay on top of the plate and extend down twelve inches on each side of the post, and is held in place with a ⅝ inch bolt, twelve inches long, or it can be held in place with the iron rod that goes across the kiln from post to post, on opposite side, which acts as a hog chain to prevent the rafter from spreading the wall. The rods should be at least six feet above the kiln of bricks, so as to be out of the way when walking over it. The rafters should be 2x8 inches, and three feet apart; collar beams 1x8 inches, fourteen feet long; two of these to each pair of rafters; one nailed on each side with ten penny nails. These will be stronger than a two inch piece, and require only small nails to fasten to rafters, while the two inch would require heavy nails that are liable to split the rafter. Directly under the comb of the roof put in a piece 2x8, twelve inches in length, between these collar beams and nail it in well; this keeps the double collar beam from warping and twisting out of shape with the heat. The rafters must be well stayed with diagonal braces, nailed on the under side of them, to be out of the way of the purloin plates above. There should be four purloin plates, the first at the foot of the rafter. The top one, two feet and a half from the peak of rafters; the other two, put in by dividing the space equally to receive them; on top of these nail good, sound plank twelve inches wide, nailed close together, with the top end of board just even with upper edge of the purloin plate. I prefer a roof covered with plank as described, so that in case of fire it can be readily taken

off. With a roof of one-third pitch, it is not necessary to have lap boards to cover the cracks. Nail the boards on single, close together, and by using burned brick for platting, whole brick, and carefully put on, you will have very little trouble from rain. I have used such a roof for the past four years, and have not lost one with fire and no damage by rain worth mentioning. If, at any time, while the kiln is hot, there should be danger of fire, every fourth board can be taken up; and need not be taken from the roof, only turned over on the next plank, and is then put down again when the kiln cools off. The main walls of a permanent kiln should be strengthened with two heavy iron rods, built in the wall, and should reach clear through from end to end, projecting far enough at each end to receive an 8x8 timber, which is fastened on to act as a buck stave on the corners, to prevent the main wall from expanding too far away from the hot kiln of bricks during the burn. Should your clay be of that kind that shrinks a great deal, the space between kiln wall and the hot bricks, would be be so great as to cause serious trouble.

CHAPTER XV.

REMARKS ON FIRING AND FIREMEN.

There is a great difference between a fireman who understands his occupation, and one who does not. I found this out in my travels among brickmakers, burning kilns of brick on first trial. My firemen as a rule were selected from among what are termed on most yards "burners;" that is, men who assist as laborers during the burning of a kiln, in wheeling wood, daubing the kiln, and sliding in wood under the direction of a head burner or superintendent. These men usually have but little skill in brick burning; none, in fact. They only labor to get the work done as directed, and as to having any care or concern in the matter is out of the question. Now to change these men from handling wood to shoveling coal, and reduce the force of firemen from five, six or seven on a turn, to only two, or one, seems to make them indifferent as to results. They were not worked as hard as formerly, but they expected they would be. They have always done just as they were told, but the telling must come every time for every move; no move can be made on their own responsibility. I think it a wrong idea to employ such men as firemen.

I have found where I had new men to instruct in coal firing, or burning of new kilns, to select a capable, willing man of some judgment, show him the importance of the trust, and stimulate him to excel by an extra reward. It made no difference to me whether he ever saw a kiln burned or not, if he was ready to learn

he was more valuable to me than the indifferent time server. Get your firemen to vie with each other, to see which can raise the best heat, with the least coal; keep the brightest and clearest flame; ash pit emptied; an abundance of fuel close at hand for immediate use; and then keep all coal and ashes separated, and a clean standing place in front of the furnace and about the kiln.

I think there are times when employers are very much to blame for the negligence of their firemen, by not paying sufficient wages; and the result is their parsimony acts as a "boomerang" on their pocket books. An owner of a brickyard who wants to employ firemen, as a rule will give no more wages than to day laborers.

This is not only unwise but unjust. There are but two changes of hands, and they divide the day into shifts of twelve hours each, and more frequently prolong their duty through a day and night, and even into two days and a night without relief. The best plan is to pay those men by the hour the same rate as day laborers; this makes their pay a trifle more, but at the same time is an incentive to ambitious laborers to earn more wages.

The employer or manager of a yard can save many times over the increased wages in the saving of fuel bills, with a good fireman, besides an increased value on the burned brick. I once burned a a kiln of brick for a yard owner who was very close in his dealings, and he would pay a fireman no more than one dollar for a turn of twelve hours. I had among the lot a man who had fired for two years on an ocean steamer. This man wanted one dollar and fifty cents per day of twelve hours. I prevailed at length on the proprietor to employ him one turn till I would try him. I found that he could fire the kiln for twenty-four hours and use no more fuel than any of the others would in twelve hours, and have a good bright heat, and everything in order as I have described, while the others would let the heat drop, clinkers collect on the grate

bars, or ash pit fill up, and slovenly work done generally. Here was a saving of not less than ten dollars per day in fuel, with an extra outlay of fifty cents. The man was well worth two dollars per day; he was vigilant, careful, orderly and faithful.

I would earnestly urge it upon employers to give this matter more attention, and secure the very best of firemen, and then retain them at wages that will make it an object to them to remain with you. I very frequently have men make application to fire a turn or two at night during the burning of a kiln. I always explain to such men that firemen on a brick kiln have a steady job at firing, and I do not intend to alternate the work from day labor during the day, to firing at night, just to allow them to earn an extra dollar or two. I want firemen, just as I would want setters, wheelers or any other class of workmen, to follow that as their business and keep up with the burn and learn something in regard to the management of the kiln during the different stages, from hour to hour, and from day to day. This applies particularly to works that turn out a steady output of bricks, and are constantly burning their wares.

A fireman who goes on duty in the evening, after doing a day of hard work, is in no condition to take hold of work so important as brick burning. He may have an idea that all he has to do is to open the door, heave in the fuel and then wait till it is burned up, and repeat the process. This might be done and ton after ton of valuable fuel burnt to cinders, and the kiln would never rise above a cherry red heat. The fireman who has this conception of the work, will take a nap while the fire burns down, and trust to luck or providence that some untoward accident or incident will waken or rouse him to make the next fire. He will quite likely feel cool and shiver enough to rouse himself to see if the fire is burning, or likely to go out; or he will find himself nodding and falling over, as he has seated himself on a wheelbarrow, or the coal

pile; or the watch will sternly call him to duty. Where a fireman goes to work rested and refreshed, and his mind made up to do his duty by keeping at work, he will not get sleepy any more at night than in the day time. There is always work enough to busy a fireman. The trouble is to get men who will conscientiously perform the work at night, as other workmen do in daylight. They take advantage of the darkness to quit and do nothing after the furnace is filled with fuel, until it is ready to charge it again. Give your firemen to understand that they are to be on their feet and constantly employed at night, as well as in day time, and a move will have been made a long way towards better burning at less cost. The first thought here is, that night work is unnatural, and brickmakers are too exacting. This is not the case; when one considers the army of men who are at work every night, the conclusion is that all night work is more important than work done in daylight, even though it is the same, and only needs to be faithfully done in brick burning, as in all other classes of work.

There is a great deal to learn about firing; that is to make heat economically,or in other words, how to make the greatest amount of heat in a furnace with a ton of coal. It matters not whether the heat is to be used to make steam, dry brick or burn them; the same principle applies with equal force to all of these. I refer now to burning coal or coal-screenings on a grate surface.

First, the coal should be taken on a dirt shovel, or small scoop. No more coal should be taken than will lay on the shovel when it is being cast into the furnace. If there be too much on the shovel, some will fall off before it reaches the furnace door, and a stray piece or two will land in the ash pit under the grates, instead of upon them; here it will either burn and waste its heat, or it will be carried to the dump with the ashes. If the shovel is filled in the right manner and the cast skillfully made, all the coal will go inside the furnace. The fireman, however, should be-

fore beginning to fire, glance into the furnace and see that the burning coke is level and of equal thickness over the grates, then he should determine quickly just where each shovelful should go, and put it there. Four or five shovelfuls of coal should be sufficient to cover eleven or twelve feet of grate surface.

If when the door is thrown open the fire is uneven on the grates, take a light hook made of $\frac{3}{4}$ or $\frac{7}{8}$ iron, of suitable length, and level it lightly without putting the iron on the grates, as that would cause the live coals to fall through and waste the fire. As soon as the last shovelful is thrown in, close the door; let this be done quickly; never stop for any purpose until it is closed, and never open the door until the tools you are to use in firing or clinkering, are in reach. When the door is opened, more oxygen is carried into the furnace than can be consumed, and this reduces the temperature. As soon as the fire is made and the door closed, with your shovel, rake back from the pavement under the door, any coal that may have fallen and leave the passage clear. The space between the furnaces and fuel should be at least three feet, and not more than five, as the fuel should always be within easy distance so that the fire can be be made quickly.

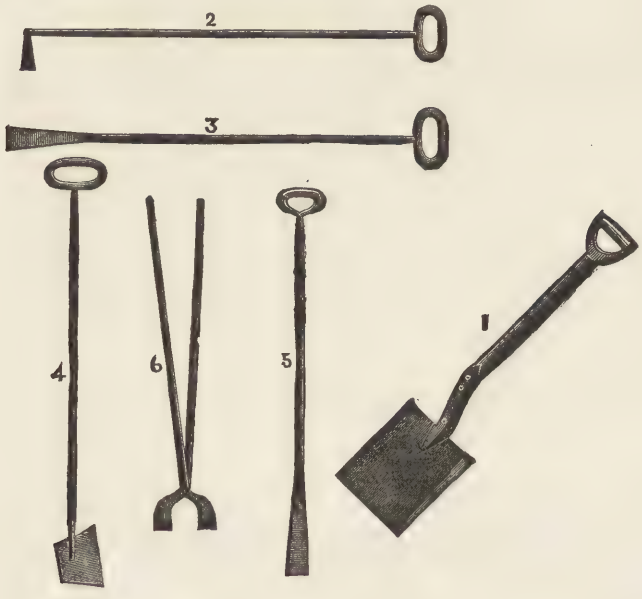
To make a lively, effective heat, the grates must be kept as free from clinkers as practicable. The best manner of cleaning or clinkering the grates, depends somewhat upon the nature of the fuel. If it makes a hard sheet-like clinker, break it up, by running a clinker bar under it, into pieces that will go through the door; with a single hook this kind of clinker can be readily separated from the live coals and drawn from the furnace; if, however the clinkers are soft and slaty, they cannot be separated from the live coals in this manner; instead of a hook, use a scraper made of iron $\frac{1}{2}$x4 inches, 8 inches long, welded or riveted to a $\frac{3}{4}$-inch rod nine feet long. With this carefully push the live coals which are always on top, to the rear of the furnace without mov-

ing the clinkers below. If the fires are low it is a good plan at this stage to throw in a couple of light shovels of coal or a few lumps, well back in the furnace on top of the live coals, and let them remain there while the grates are being cleaned. When this has been done, scrape the ashes and clinkers through the door, leaving the grates bare and clear. The live coals can then be drawn forward on the grates and they in turn covered with a thin layer of coal, and heat will soon be restored. By pushing the fire back before clinkering, it leaves the burning coke to cover the grate bars, without falling through, as fine coal is apt to do and helps to keep the fine coal in place until it is well ignited. Another advantage in pushing the fire back is, that it prevents the cold air from rushing in and chilling the ware in a burning kiln.

How often the furnaces should be cleaned out, depends wholly on the nature of the fuel; but as often as the furnace fails to keep a bright clear heat after the flame disappears, just so often must it be cleaned; whether it be once every two hours, or every six hours. Another important point, is to keep the ashes from getting near the grate bars. I think an ash pit should be at least twenty inches deep, and the ashes should be kept never less than twelve inches from the grates. If by any means the ashes or the coke that is carelessly knocked from the grates, get red and hot in the ash pit, either remove them at once, or cool them with water; this will prevent the grate bars from being melted or warped.

A grate bar to burn fine coal should have slots for draft, $\frac{1}{2}$-inch to $\frac{5}{8}$-inch wide, varying to suit the coal used. The fire doors should have a plain surface on the inside, and be braced on the outside by ribs, cast in the shape of a four pointed star. The star raised one and a half inches above the face of the door. The ribs should join the door by means of an even curve, instead of an angle. The door must have from twelve to sixteen holes through it of $\frac{3}{4}$ or $\frac{7}{8}$ inches in diameter.

There is one thing a fireman should not do; that is, sleep between firings. Good firemen like detectives, never sleep while on duty. The intervals between firings should be regular, but the length of a nap I have never been able to determine, or even approximate. When a fireman sleeps on duty while burning brick, the kiln is injured by a reduced temperature, and again when he wakes up and begins to try and make up the lost time, the ware is likely to suffer damage from too much heat. Vigilance and judgment are needed in brick burning.



The tools necessary for a fireman where coal is used, are illustrated in the engraving. No. 1 is a No. 2 dirt shovel. I consider this better than a scoop as there is a saving in fuel, and allows the coal to scatter evenly over the fire. No. 2 is a rustling iron used also to pull out clinkers. No. 3 is a clinker bar made of 1-inch or

1½-inch iron to break up or lift from the grate bars heavy clinkers. No. 4 is a scraper to clean off the grate bars when fouled with slate or small clinkers. No. 5 is a chisel shaped iron of ⅝ inch round iron which is very useful in closing up or tightening the platting during the burn. No. 6 is a pair of tongs made with a chisel edge, on the jaws, and is used to handle the platting, and is a great convenience in closing cracks in the platting when closing up, or to handle hot bricks, which is necessary many times while burning a kiln. Have a set provided for each side of the kiln.

CHAPTER XVI.

UNLOADING A KILN.

The best and cheapest method of getting bricks from the kiln, and loaded into cars, is a question that has not yet been determined. Most yards have their kilns side by side, with their car tracks running by the ends of the kilns. Wheelbarrows are used to carry the bricks into the cars. Usually in this way, one man can load from six thousand to seven thousand a day. This answers very well where from four to six cars a day are loaded from one kiln. But when fifteen or twenty cars a day are loaded from one kiln, wheelbarrows cannot be used, as there is not room to work the number required.

Some have tried an endless belt to carry the bricks into the cars, driving it by horse or steampower. It carries the bricks fast enough, but it requires considerable time to raise and lower it to suit the state of the kiln, and to shift it from one part of the kiln to another. It might be made to work profitably, but it is doubtful, however, about its coming into general use as a brick conveyor. It seems to me a wire cable inclined toward the car with boxes suspended and arranged to travel in with the load, and return an empty one on a similar cable would be a better plan. When loading from the bottom of the kiln it would be necessary to elevate the load above the bottom of the car, enough to give it sufficient incline to carry it to the car.

There would be difficulties to overcome in this plan; but

some inventive genius may accomplish it. We simply call attention to the plan, and would be glad if some way could be devised to make lighter this hard task of carrying brick from the kiln to the cars.

There is another plan that might do away with much of this labor; which would be to lay a temporary track into the kiln, and put the car into the kiln, so that bricks could be tossed into the car direct, without rehandling or wheeling. This would necessitate a separate switch track for each kiln, or a turn table in front of each. The latter would be more practicable, requiring much less room, and less time to remove a loaded car from the kiln,and put in an empty one. In this way there could be loaded ten thousand brick a day, to the man employed; and there would be no trouble to work ten men at loading one car, providing it is an open top or flat car; box cars would be a hindrance to this way of loading. The temporary track in kilns, could be made of light rails, or wooden stringers with strap iron on top, so as to be moved in sections with little labor. As to moving the cars either loaded or empty, with a proper car pusher or lever costing five dollars each, two men can move a car, without much trouble when the tracks are nearly level as they should be. The grade of the switch tracks has much to do with the economic handling of cars. The cars of fuel and supplies. together with the empties should stand on the highest part of the track, so that when moving them to the kilns, and away from them when loaded, they are going down grade, and are easily moved. After you have determined upon the method of conveying the bricks to the car, the next step is to consider the manner of handling and caring for them, to insure them the neat, finished appearance that is desired in any product.

The brick itself has a very rough time of it after being dug up in the clay bank, and is subjected to a great deal of rough usage until it finally rests quietly in the wall for a time. The

green brick is supposed to be a frail article; liable to become soft from moisture; or, if frozen while in a damp state, will crumble on thawing; it will also crack in drying or burning, or become broken, shattered or marred in handling at some point between the machine and the finished brick laid in the wall.

On a great many yards, after the bricks are burned, any further care in the handling of them seems to be entirely ignored. Instances and places could be stated where the bricks are made and burned as good as could be desired or expected with the machines and appliances. The pressed brick, in particular, are all made very carefully, and in fact no better can be found anywhere as a rule. These pressed brick after being carefully made and dried are taken from the hacks and placed one at a time on the brick barrows; each tier on the barrows is carefully brushed with a dust brush; soft blankets are used between tiers, and light slats interposed between in the courses. They are set in the kiln one at a time, as tenderly as if they were fine ware.

Sometimes there is a rush of orders for pressed brick, and in the eagerness to fill orders promptly, they are taken out of the kiln first and while yet warm. The pressed brick being below, part of the common stock have to be uncovered prematurely, and the top courses of rough brick are piled back on top of others, and are thus in the way of everything below them. Presto, the change is now to see how much they will stand in the way of hard knocks without breaking, and through carelessness or indifference in the matter all attempts to retain their nice, finished appearance as taken from the kilns seems to be abandoned.

They are taken up two or three at a time, or more, according to the strength or disposition of the man loading the barrows, and in some clays, if the bricks have been well burned, they may be adhering to the faces just enough to cause them to lightly stick together. A blow with another brick will bring them apart or

make the spawls fly; or worse yet, reduce them to bats. They are piled together in heaps or layers, on tray barrows, and wheeled over uneven runways to the cars or wagons, and by the time they are delivered at their destination they are full of scratches and mars, and corners knocked off, they look as if they had been left over from the Tower of Babel.

That is how not to unload a kiln of bricks. It is a poor advertisement to any company and a standing disgrace to the man who makes and burns a good article, as his work has gone by default and the bricks ruined in their appearance by careless handling. All bricks should be handled with care enough to insure good faces on at least one-fifth of all the common stock. The pressed brick are supposed to have each one good face, and that should be kept free from all defects, all the time, until it is laid in the wall; and even then the mason should use every precaution to keep them from being stained or daubed with lime or mortar while the building is in progress.

On opening a kiln, let the platting be taken up carefully, and set back on top of the clamp walls; and all salmon brick or light courses on top be taken down first, so as to get at the hard brick below. In unloading clamp kilns, begin at each end, and strip down to the top of the pressed brick courses. Then take out all the pressed brick, and do not mix them with the common brick, beginning at the front at each end, so as to get all clear to that level. Use every precaution to keep the faces of the brick clean and free of mars of all kinds. A kiln of bricks will unload easier beginning at the end where you left off setting, and go back in reverse order, taking out first those set in the kiln last; time can be gained in this way; try it. And, also, in connection with this subject is the loading the brick on the car or wagons. Begin with a clean, level floor on bottom of car, and put a fine scattering of straw, or marsh hay on the floor, and then put the brick carefully

in place one course at a time. Between the courses of brick, put straw enough to keep the bricks from being rubbed or scratched by contact in transit. Let this part of the work receive as much care as at any time during the process of making, as your bricks cost you more each time they are handled, and to all these handlings must now be added the cost of burning. Then when your pressed brick are all out, unload to the top of the benches including the overhangers, and as soon as the first arch is opened, let all bats and rubbish be dropped into it out of the way. Square up the work on this level to the walls on both sides. Much time is gained in this way; your work is orderly, and the brick can be graded as loaded. While in the former case of digging holes to get at the pressed brick, much time is lost or wasted, and many bricks are spoiled or broken, and on works where a continuous stream of bricks is expected every day, it is just as important to unload the kilns quickly as it is to set the bricks in the kiln quickly. After the bricks are all out to top of benches, then remove the benches and rubbish, one arch at a time, and your floor is soon cleared.

CHAPTER XVII.

HINTS ON WHEN TO START.

Parties who contemplate starting a new brick plant, will begin to enquire when is the best time to start work, so as to enter the market with the product? The best time, as understood to be meant, is what is the most favorable time of year to begin operations, in point of economy and assurance of market for the brick.

There was a time in the history of the country when no one entercd into the business of manufacturing any commodity, without some previous knowledge or experience in that particular line. But now when capital is seeking investment at all points, men engage in the business of brickmaking who have never been on a brick yard in any capacity, and the inquiring business mind will ask such questions as are naturally suggested. Our answer to all such is, very early spring is certainly the proper time to open work on the new yard or plant. In speaking of a brick plant, a permanent one is meant; that is, with steam hoist engines, machines, artificial dryers, permanent kiln, etc. Among the good reasons for beginning at this time of the year is, the weather is more likely to grow better and more favorable for all kinds of work; while if started in the fall months, the weather will be growing worse all the time, and much work will be done at a great disadvantage, and consequent loss.

I have seen firms begin work in October, expecting to have

their plant built and perfected, and making brick in a month or six weeks, that were not ready to fill large orders for brick till the following May; and all work done in the meantime was done on a strain, up grade; because of the wet and cold, mud and freezing, rains, thaws and general discomfort in the effort to build the works, and make brick without ample preparation.

By all means begin in the spring, even if your sales are not as heavy the first year as you may desire; experience teaches that they will be as large as you can attend to and carry on the work of perfecting your plant. First select your machinery, engine and boiler, and order them; also all lumber necessary to build a good engine house, machine building, tool room, etc. These buildings should be made permanent and safe from the start.

Then grade your yard, with a fall of one foot in one hundred; provide drains so that surface water will be carried away quickly; begin making bricks as soon as there is no probability of frost destroying the bricks, and dry by sun, heat and air. Provision must be made to protect the product, so far as possible from the rain. However, if some of the bricks are damaged somewhat by rain, they can be burned and utilized in building your temporary walls as well as the permanent ones. The product of the first season, or part of it must be burned in temporary walls, and in burning this way there will be a certain per cent. of arch brick damaged more or less, and probably more salmon brick than can be sold. These can be set aside for building the permanent kilns and dryers.

Bricks cannot be burned in temporary walls, or even permanent walls, without more or less damage to the arch brick, unless the latter have furnaces attached to protect the brick from sudden shrinkage, caused by drafts of cold air when burning. No man, however skillful, can prevent cold air rushing in the fire hole when he is putting in fuel. This, I think, is plain to every practical

brick burner. By setting aside the damaged and part of the salmon brick, you are enabled to give your patrons a good quality from the start, thus securing their custom. Salmon brick should always be protected from the rain and dampness, to save them, as they will dissolve, if exposed to the weather.

As soon as a sufficient quantity of brick has accumulated, begin the building of clamp walls, and in the latter part of the season begin building artificial dryers, of whatever kind you may choose, from among the many in use, and before, or by the time cold weather comes, have the dryer ready for operation.

During the fall and winter build as many additional clamps as may be needed, and by the time spring opens, your plant is completed and ready to turn out good bricks with the full capacity of your works every day. This is the most economical way in all the details of starting and enables one to put in a plant with much less capital. I have known men to buy bricks to build their dryers and clamps. This, I think an extravagant way to proceed. If the brick used in construction are manufactured at the plant, they get them at cost; if they are bought, they must pay cost with profit and cartage, or freight added.

Before the work of building the plant begins, determine whether the fuel used will be wood, coal, oil, or gas, and the cost of same delivered at the works. If it is coal, contract for the year's supply at the most favorable time. If wood is to be the fuel, be sure to have a season's supply where it can be reached when wanted. Next to labor, fuel is the most important item in brick manufacture, and this question should receive careful attention. Judgment should be exercised in purchasing wood; good split wood is cheaper at $3 per cord than are poles, soft or decayed wood at $2 per cord. The same is true, in a manner, of coal; it is better to pay more and get clean, pure coal, for we must remember that there is no heating power in cinders, or ashes, and impure

coal requires more labor to fire with it. More heat is wasted, as the furnaces require more frequent cleaning, and this is always attended with a certain loss of heat, and, as a consequence, longer time is consumed to burn the brick.

There is no doubt that the very best way to economize heat and fuel in burning is to hold the heat on the ware as hot as it will bear, and without intermission, thereby economizing heat; and it improves the quality of the ware burned, and there is no method of doing this except in kilns properly constructed, with heavy walls and furnaces.

CHAPTER XVIII.

BURNING BRICKS WITH NATURAL GAS.

In the early history of the manufactures of this country, the only fuel available for steam purposes was wood. Later this was supplemented, and even entirely supplanted with coal in many sections, as the mines were opened up and worked. Coal was then used in its various ways in the factories, furnaces and mills, as fuel direct, or as coke, and also to some extent as gas. This was continued with varying degrees of success, until the discovery of petroleum in Western Pennsylvania, late in the fifties.

For several years after the discovery of oil, its principal use was for illumination, or as a lubricant; but with the advances made in all the arts and sciences, progress was made here also; and its products and uses were multiplied and varied, beyond the conception of the most sanguine.

It was predicted soon after the discovery of oil, that on account of its abundance and cheapness, and its inflamable character, it would eventually be used as fuel in lieu of wood or coal. No account was made at that time of the gas which accompanied the flow of oil in nearly every case, and in many instances where a hole was drilled for oil, and abandoned as a dry hole, gas continued to flow in an uninterrupted way for years afterward, without any attempt to utilize it as a manufacturing agent.

The writer remembers seeing a well that was drilled for oil, that at a stated depth encountered a fissure in the rocks, from

which the gas burst forth with tremendous force, and was ignited by the fire at the engine which worked the drill. All the wood work of the derrick and buildings were consumed, and the well continued to burn for years afterward, the flame shooting high up in the air with a roar that could be heard for miles up and down the valley; the flame mounting as high as the tops of the tallest trees in the surrounding forest. Cases similar to this were numerous throughout the oil region, or adjacent to it, as the two products seem to be correlative. There was a few feeble attempts made to shut off the flow of gas, and extinguish the fire, so as to go on with the work of drilling for oil, but without success until in recent years.

There were some few individuals in the vicinity of the oil or gas wells who made experiments in a rough way with a view of utilizing the waste gas, to warm their dwellings or for kitchen uses.

An uncle of the writer made some such attempts, but was looked upon as a trifler, or dare-devil for tampering with a substance that seemed to have its origin in the infernal regions, or down in that supposed direction of them, and possessed such a highly combustible and apparently destructive nature.

His experiments were not with gas alone, but oil also; and many were the scares he gave himself and family, before he arrived at anything like success. With the pipe fittings from old abandoned oil wells, he piped the gas to the kitchen stove and fire place, and continued to use it for a long time before it came into general use. Our recollection is that his neighbors made him a laughing stock by insinuating that laziness prompted him to devise this means to avoid chopping wood. The laugh on his side came late but was expressive.

The city of Erie, Pa., was probably the first to adopt any method of utilizing the gas in an economical way, for heat or

illumination, and this was done in a crude or wasteful manner for many years. But as it gradually became known and recognized, appliances were perfected for controlling the flow at the will of the consumer, until in its present state we have apparently the ideal fuel which, when handled with proper care, possesses more desirable characteristics than any other. It is easily regulated, constant, serves both for light and heat, and can be adapted to any stove or fireplace that uses wood or coal. It is entirely free from bulk, weight, dirt or ashes,and no big lumps to be missing in the morning. It is quick in its operation, and has no variation after adjusting the flame; it burns with a heavy, dark yellow flame, depositing carbon, or soot, when too strong, or insufficiently supplied with fresh air, which is necessary to perfect combustion of any fuel; but if turned low enough to keep up a low heat, the flame is a dark blue, vaporous flame, similar to a sulphurous blaze, or that given off from a fire of coke or charcoal. It is burned in the dwelling for fuel and light; it is burned in the kitchen stove, and the parlor grate. *Apply the match*, turn on the gas, and the fire is made and the work done for the day, so far as the heat is concerned. It is well to bear in mind that the above directions, say *apply the match first*, and then turn on the gas, as by turning on the gas first, if you should be late with the match, the stove becomes filled with gas, and would be likely to be wrecked with the explosion, which would inevitably take place. The grate is filled with brickbats, pieces of broken sewer pipe, or broken castings, or old door knobs, etc., or any incombustible material to hold the heat, and it soon warms a room or a whole house. In winter a small amount of gas is left burning all night in the grate or stove, and the rooms are warm in the morning. It is a great saving of time and labor, and is cheaper by far than any other fuel yet discovered.

It cheapens manufacturing on account of its utility, epescially

the manufacture of iron and clay products, because of the great, amount of heat required in the working of these two products some manufacturers needing fuel only for power; so manufacturers of iron and clay are benefited by this cheap fuel in a greater degree than most others. I am glad the brick manufacturer has been benefited by it, as well as others, and that bricks can be economically dried and burned with natural gas for fuel.

Most of the brickmakers in Pittsburg, Pa., and near there, use natural gas and hot floor dryers for drying brick. As far as drying is concerned, it is a grand success; there being no soot or ashes to impede the heat, or act as non-conductor. The floor is heated the whole length, requiring no labor whatever.

After natural gas was determined upon as a fuel for domestic purposes, it soon was demonstrated to be a proper fuel for manufacturing purposes also. Companies were organized, lines of pipe laid from the gas territory to the adjacent towns and villages; contracts were made to supply fuel gas for a term of years at a nominal sum. The brickmakers in many cases, availed themselves of these offers, and pipes were laid to the works, as at all other places of manufacturing; they agreeing to pay a certain price per thousand for the drying and burning of the brick, or for the burning alone. The pipes are inserted into the furnace just above the fire door, as understood for coal burning furnaces. The ash pit and door are bricked up solid, and air for combustion admitted through the same opening which the pipes enter, and this is arranged to be opened or closed, at the will of the burner or man in charge.

In the matter of brick burning, by admitting more of a volume of air the flame is increased, but does not seem to heat the kiln so well as does a smaller quantity of air and less flame When a kiln of brick is in full blast and raising heat the roar of the escaping gas and rush of flame is so loud, the men about the

kiln can scarcely make themselves heard unless they speak loudly. Some of the brickmakers say it is a complete success; others claim their arch bricks are not so sound. This difference is explained, I think, in this way: Those who formerly used the old style clamps had damaged arch brick in burning with coal, therefore find them no better, or worse in burning with gas. While those who have burned with furnace attachment kilns and had sound arch brick in burning with coal, find their arches damaged in burning with gas. We think, however, if properly arranged and managed, much better results can be obtained from burning gas in furnace attachment kilns, than without, as the cold air will damage the arch bricks when it enters the kiln directly with the gas, before it has been heated. A chamber outside the walls for combustion of the gases and oxygen, is the only way to prevent the damaging of the arch bricks. The writer examined a kiln of brick that was about ready to close up. The fires were perfect, the heat uniform as in the improved kilns, but, there were defects in the method that looked as if they might easily be remedied. The heads were high and the green brick were dark next to the wall. The centers of the arches, or closing courses, were down three inches lower than the benches, on each side of the arch. These matters can be remedied very materially, and with a fuel as perfect as gas seems to be, there ought to be perfection in the burned ware. The setting of the brick to distribute the heat equally through the benches, would make the settle alike all over, and then an ample provision for draft on the heads next to the walls, would help burn the bricks out at that point.

Our experience in burning bricks with wood and coal, in old style out door klins, and by improved methods with furnace attachments, prompts us to suggest these means as a remedy, as all brick burning is virtually the same, no matter what the fuel.

A gentleman near Pittsburg informed me that he paid the gas company, eighty cents per thousand for the drying and burning of his bricks. He reports to the company at the end of each month, the number of thousands he has dried and burned during the month. If he uses any coal during that time it is charged to the gas company, and deducted from their bill. There is one great satisfaction about this system—the brickmaker knows to a cent all the time what it costs him to dry and burn his brick. All through the gas producing section it is used in the iron works, forges, rolling mills, etc., and Pittsburg, much to my surprise, I found as clean as Philadelphia. It has been known in the past as the "Smoky City." The term has lost its significance. In riding through the gas fields and much of the adjacent territory, and through the Ohio valley below Pittsburg the gas can be seen blazing from the gas posts in the day time. These are usually two-inch pipes, with an opening of sufficient size to make a flame of three or more feet in height, and being without glass tops, look like great candles, and to the observer, one would expect to see the melted tallow or the consumed post, with a flickering and expiring flame.

There is but one question in my mind about natural gas, and that is: Is the supply inexhaustible? We know the petroleum wells are not. They first spout or flow, then they are pumped, and finally the pump fails to bring up the unctuous fluid,and it is abandoned for newer basins. Gas has been found in greater or less quantities wherever oil has been found, and seemed to exhaust itself in the same manner. These reservoirs of gas may be inexhaustible; if so, the process of generating it is perpetual. Since the discovery of gas in Ohio and Indiana, these sections bid fair to rival the oil and gas district of Western Pennsylvania. It is of immense benefit to the people now. However, I suppose a great syndicate will be formed to control all the gas producing dis-

tricts and the prices also; as most all the good things and necessaries are monopolized in this way.

We lately saw an article in one of the trade journals calling attention to the fact that some of the large iron mills in Pittsburg were about to discard natural gas as fuel, and this was having a tendency to discourage manufacturers at other points who had located in the gas field. It would seem from the statements made, that gas as a fuel had in several respects been a disappointment. A great deal of loss had been experienced by owners of mills and workmen, also, on account of the frequent failure of the gas supply, and that it would only be a question of time when they would all turn to artificial fuel, for all their wants and needs in that line.

The next substitute for fuel after natural gas, is gas manufactured from either coal or oil, either of which is feasible and measurably successful, considering the limited range of the experiments in that line. Coal has been reduced to a fine powder and sprayed into a furnace in a shower of dust in combination with a jet of dry steam; this is reputed to produce an intense, white heat at low cost. Oil has also been fed into the furnace with steam, and makes a fuel that is free from objectionable qualities, and again the oil has been heated to a certain point at which it is resolved into a gas, differing but little in its nature from the natural gas. While in a few cases oil and steam are being used as fuel in drying and burning brick, yet we feel that the matter is not yet perfected enough to advise brickmakers to invest in the oil burners. It is as yet in its infancy, and the methods too expensive or unreliable to adopt for general use.

We hope the time may soon come when we will be able to advise oil for fuel in brick burning. Since natural gas is confined to limited areas, oil can be transported to distant points and then converted into gas, and used for all purposes, as natural gas.

CHAPTER XIX.

BRICK AS A BUILDING MATERIAL.

There is a saying that "a brick is a brick." In other words, rough or smooth, red or yellow, it is a brick. This is a great mistake. There is just as much difference between a good brick and a bad one, as between a good egg and a bad one. I have heard men say, "I prefer brick to wood for my house, but brick is too plain. I can have a frame house as I like it. Wood is more capable of ornamentation than brick." This is too often the case, for we know how a house built of rough and poorly burned brick looks.

It is true that the walls sometimes exhibit a variety of colors, like Joseph's coat, ranging all the way from a bilious yellow to a blue black. These colors, however, are not in regular stripes, but after that style known as crazy quilt pattern. Such brick often prejudice men against brick for fine houses. On the other hand, we know that a house built of well made, well burned brick, laid in white mortar, trimmed with stone, terra cotta, or fancy patterns of brick, certainly makes a beautiful and durable building, one that will stand for centuries in any climate, and is nearer fireproof, than any other frost-proof material used in building.

It has been but a very few years since the art of brickmaking has advanced far enough to give us molded brick, or ornamented designs, beyond a few designs in angles or circles; these were employed on bay windows, or irregular corners and openings, or

to a very limited extent in cornices, but with the rapid advance made in our architectural designs, and our demand for some ornamentation in brick houses, as well as wood, came the improved methods of brickmaking, and elaboration of our brick buildings with molded water tables, belt courses, arches, corbels, spandrels, lintels, mullions, dados, friezes, consoles, base courses, and, in fact, any and all parts of the structure, are now ornamented in a multiplicity of designs, that are far more pleasing to the eye in several respects, than wood or stone; more substantial, and in every way better, so that it is no longer a plausible excuse, that wood can be ornamented better than brick. A glance at a first-class house of to-day will convince the most skeptical, either on the exterior or interior. A wooden house will be an old house in appearance in thirty years; and in that time will have received no less than ten or twelve coats of paint, to keep it looking respectable; while a well built brick house will improve in its looks. The eye will delight to linger on its walls, gables and angles, with their lines of light and shadow, and its general effect, as a picture. The natural color of brick is much more pleasant to the eye than the bright glaring colors of the shops, laid on in oil, which soon fade, wash off, blister or peel, and, in short, are unsightly. The different colors of brick, disposed in panels, belt courses, and lintels, in one shade, with all plain walls in some other prevailing color, or the house trimmed in stone or terra cotta, make a picture that cannot be produced with wood and paint, and have anything like durability. This is a matter you can easily prove to your own satisfaction.

Hunt up some of the old houses built in the fifties, or previous to that time; they were marvels of skill and workmanship—veritable palaces. I speak now of the best class of frame houses that were being built all over the country at that time. You thought those houses fine. You kept them in mind as an example or

model to pattern after as you grew up to manhood, or if already grown to that estate, would have such a house when you built. Go now and take a look at those houses; some of them were built in close proximity to an old brick house of fair pretensions, and you can find them both still standing, and note the difference in the two; I venture to say the brick house has hardly changed, while the frame is an old pile of loose boards, decayed sills and steps; it is hardly fit for a habitation for man.

There are quite a number of buildings in the cities along the Atlantic coast that were built of brick brought across the sea; some from Holland, and others from England. One that the writer recalls having seen in Norfolk, Va., is a church built of brick brought from England, which bears the date of its erection in the gable, by the brick built in and projecting an inch from the face of the wall as headers, forming the figures in an irregular outline to correspond with the brick work and form in figures, two feet or more in length—1 7 3 9. The brick that form the outline of these figures are the arch brick, that are glazed a brownish black color on the ends that came next to the fire. These glazed brick are noticeable all over the face of the wall, and laid in without regard to any design, form a quaint picture, in comparison with a fine pressed front as constructed at this day. These English brick are smaller every way than our sizes as now made, being about $7\frac{1}{2}$x$3\frac{1}{2}$x$2\frac{1}{4}$ inches. They were burned hard enough to stand the weather in this unfavorable climate, but are all shades from a yellowish red to a dark cherry red, and on down to brown and black among the arch brick. This church, antiquated as it is, still has an air of gentility that compares very favorably with buildings put up within the past forty years, and far surpasses the unsightly wooden boxes we see so frequently all over the country to-day.

There are to-day, in different sections of the East coast, some

good examples of old brick work, dating back from seventy-five to one hundred years or more; and but few structures of frame that are considered of any consequence, that have been standing over fifty years.

A brickmaker who makes good brick, that are uniform in shape and color, should take his customers to buildings built of different qualities of brick, and show them the difference in appearance when laid in the wall. This brick wall argument is conclusive, when it is properly presented to sensible men; they can see it is cheaper to pay more and get good brick; here is where it effects both the brickmaker and consumer. Some object to brick houses because the walls are damp. I find this objection prevails largely in the Southern States. The preference is for a frame house, that can be set up on brick piers or wooden posts to give a circulation of air under the house. The claim is that a house with a brick wall under it, is a place that will breed fever and disease. But the argument is only an open acknowledgment of their ignorance of the building business. Houses can be constructed of brick with large rooms, well lighted and ventilated under the whole superstructure and used as a basement story, and be no more productive of disease, if as much so, as in the case where the houses are built in detachments, one part separated from another with an outdoor space between sections, as is so frequently seen in all parts of the South.

It is well known that hollow walls with inlets for air at the bottom and outlets at the top, will keep the inside of walls as dry as any wooden building. Sometimes there is an excess of moisture in the ground and the dampness rises in the walls by capillary attraction, causing much trouble and annoyance, and is frequently the primary cause of much sickness in such places. There are several ways to avoid this. Where a building has a stone foundation, there is not likely to be much moisture rise

from it to the brick wall above. Another plan is to have a good system of underdrains laid underneath and all about the building. The earth should be graded higher next to the foundation walls to carry off all moisture, or surface water. The foundation walls should be built up from two feet six inches, to three feet or more above ground, before the first floor joist is laid on. Near the top of this foundation, and below the floor joist, a course of roofing slate should be laid between the bricks and well bedded in the mortar; this will effectually cut off the absorption of moisture from the earth, and there will be no trouble from damp walls on lower floors. There is another source of dampness which we will consider here. When a driving rain beats against the wall of a brick house, the bricks absorb this water very largely; and where a rain of this kind lasts a few hours, the dampness penetrates to the inside on the first and sometimes even the second story, so that the water will stand in drops on the inside walls. This water is not always that which has penetrated the wall as rain, but is water condensed on the cold wall, from the warm air on the inside of the building. However, the effects of the dampness are the same; and where walls are nicely papered, or decorated, they are very often sadly damaged, or entirely ruined.

The remedy for these damp walls and foundations are not properly in the hands of the brickmaker, but rather the bricklayer; but the bricklayer in most cases neglects this very important item in his work. He has not the competition in his trade that other branches of the building trade have, and his work is hurried and in many cases illy done, to what it should be. But the brickmaker should be up to all these points and be able to instruct his patrons, and then it can be required of the mason to build such work as he desires.

In building a hollow wall, where the header or bond course of brick comes, lay a Flemish bond; which is a header and

stretcher alternately. These headers bond the wall on the outside, to the inner wall, and leave a space between the two of one and a half or two inches, of a chamber continuous from bottom to top, and a free circulation of air throughout; the rooms inside are then equable in temperature, dry and comfortable; being much cooler in summer, and warmer in winter, as it is also frost-proof. This hollow wall I have built in several instances, where I have had an opportunity, and the results are highly satisfactory.

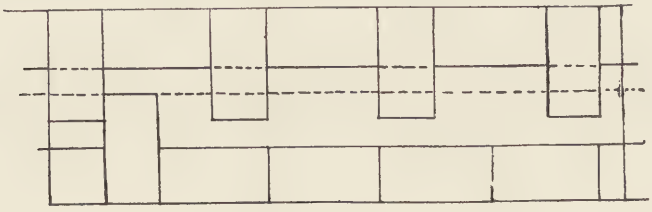


DIAGRAM OF HOLLOW WALL.

Brickmakers and builders should give this matter of damp walls and cellars more attention; dampness being the most serious objection that can be brought against the use of brick; and few people know that they can have a brick house as free from dampness, if properly constructed, as any frame house. It costs less for repairs and insurance, and can be made as attractive in design as desired.

Let the bricks be made still more beautiful in finish, color and design. It is plain that it is to the interest of brickmakers to make not only a good brick of durable quality, but they must avail themselves of the real improvements for the handling and preparation of the clay and the molding, drying and burning of the bricks, so as to produce a brick well finished in appearance, perfect in shape, and burned in a manner that will bring out its very best color, and be hard enough for durability.

Bricks will undoubtedly be the great stand-by for building

material in the future; of this there can be no doubt. It is true stone will also be used largely, but not to near the same extent, for the reason that stone is more expensive; it costs more to work it into shapes or forms of beauty and utility, while the plasticity of clay, allows of an infinitude of designs and beautiful forms.

Clay products are among the first articles of manufacture of any race of people, and by their advance in the art of clayworking we judge of their advance in civilization. Just how soon we will reach the point when brick will be more in demand for the walls of our houses than wood, depends in a great measure upon the brickmakers; and if I can read the signs of the times aright, they are arousing from their lethargy and shaking the dust and cobwebs of ages from their industry, and are leaving the beaten track which their predecessors have followed with blind devotion for centuries. I hope to live to see the day when our art will take its place in the front rank of the great industrial procession, a position to which its usefulness and its great antiquity justly entitle it.

The desired object or aim in all building operations is summed up in the following three requisites: First, stability; next, utility; then ornamentation. We will not discuss these points separately, but leave them for your consideration.

There is no manufactured material so universally employed the world over as bricks, in some form, nor none that has been so long in use. That clay was used for building purposes was on account of the ease with which it could be worked and shaped into cubes, or other forms, for building blocks, and afterwards dried or burned to retain their shape. Stone for building purposes was not nearly so abundant, nor so readily formed into proper shape for building purposes.

Primitive man, like the race of to-day, sought the most fertile lands; those lying contiguous to streams, on broad savannas or in rich valleys; and in these sections stone was not near so

plenty as in the hilly or mountain districts, but were plentifully supplied with wood and clay. Necessity required him to construct a habitation quickly and easily; first as a shelter from the storms, and also as a defense from wild animals. His first rude efforts can only be surmised; later, he may have built his house like the more recent emigrant, who, in Kansas or Colorado, made a sod house from the turf or sod of the prairie; building it up like a stone wall, and, by arching it over or drawing in the top, covered the structure with the same material as the walls. We do a great deal of reasoning by analogy; hence those of us who can remember the old Dutch oven of our grandmothers, built out of doors on a platform of suitable height, over which was spread a thick coating of tempered mud; then on this clay floor was piled up in a conical or dome-like shape, small twigs in the bottom, with heavy wood on top, and then brought into the right shape to form the inside of the oven with bark and chips, until its shape was something like the capital letter D on the bottom of oven; this was provided with a door about twelve inches square, and an opening at the rear as a vent or draft. Over this pile of wood and bark was spread a thick coat of tempered mud some three or four inches thick, and well kneaded into shape; this was covered with something to keep off the sun and wind until it was thoroughly dry; after which fire was applied to the wood on the inside and all burned out, leaving it stand like a half burned brick on the inside; these ovens would stand, with care and slight shelter, for years; and many a savory morsel has been prepared in them, as the writer can testify to his own delectation. So that reasoning from this point we can infer that in this way and manner, was evolved the house of those early times. This method was probably improved upon to allow of additional size and solidity without weakening the structure by also burning it on the outside with wood heaped over the structure.

While iron plays an important part in all structures, yet its use is limited to certain parts only, and is not likely to ever be adapted to the building of walls, roofs or floors of houses. While it is abundant, yet it is limited in its area of distribution, and transportation adds to its cost, and is only used where strength and lightness of construction are needed.

Clay for brick or for building purposes, is the most abundant of any known substance, and is capable of being quickly and easily fashioned into some shape, either rude or artistic, that renders it portable, durable, and efficient.

In the early settlement of this country, wood was almost the only material used in the construction of all buildings; and this, on account of the abundance of timber of all kinds suitable, has continued almost uninterruptedly up to the present time. But the enormous consumption of wood in all its various uses, as required in our advanced civilization, renders that article too expensive to enter wholly, or even largely, into the construction of our houses. Our people to-day are too well informed on all general topics, to be very far behind in the race for supremacy and leadership in the school of political economy; and they have discovered the fact that wood is an expensive material with which to build a home. And very naturally the question is suggested: What shall we use as a substitute for our wooden houses?

That brick is to come into general use for the walls and foundations of our houses can scarcely be doubted; for the reason of their being indestructible in their contact with the weather, water, or fire, and the almost unlimited and universal distribution of clay suitable for their manufacture.

In treating the subject named above, viz., the requisites in all building operations, we have, in a general way, only spoken of, or considered them, in the point of durability and utility. While the subject has by no means been exhausted, we feel that we have

only touched lightly upou it, and leave it that we may pass to other points that concern us more directly.

In the fore part of this chapter we state that it is only within recent years, that the art of brickmaking has advanced enough to give us molded or ornamental designs in brick work. Let us be understood on this point. There are so many kinds of clay ware that have been subdivided into classes, each class separate and distinct; and in the line of progress in the art, they trench one upon the other. But we think it best to follow the masses in classifying clay products into four distinct classes, and these in turn subdivided. Beginning with bricks, which is the rudest form of all clay ware, and as we go up in the scale we leave the original brick and come into the realm of terra cotta. And so it is with pipes and sanitary ware, as we ascend in the scale until it attains the highest excellence in the potters' art in earthenware and porcelain products.

The ancient nations of the Old World employed terra cotta in architecture, as a means of ornamentation as well as for its indestructibility—the Greeks more largely, perhaps, than any other. Strictly speaking, terra cotta means, earth baked, and is meant to be applied to any fictile object that has been burned or baked; but in its architectural sense, especially, implies the finer articles in decorative work, in contradistinction to the plain brick.

Terra cotta articles are supposed to be those parts of the structure that are incapable of being formed of plain brick, made in large pieces, and on account of the ornamentation, requires a clay of certain peculiar properties in respect to plasticity, shrinkage in drying and burning, and also in color; and, in this way, is not considered as brick. Both Greeks and Romans employed it largely, not only for architectural purposes, but for an immense variety of other uses and objects, from the commonest articles of every day use to the most elaborate and ambitious works of art;

such as colossal statues and groups. It was also used in miniature busts, statuettes, jewelry, sarcophagai, inscribed tablets, tiles, etc., etc. In some respects the use of terra cotta or burnt clay has great advantages over marble or stone, in the sculptor's art. The soft clay is easily and rapidly molded into form while the sculptors thought is fresh in his mind, and for this reason, terra cotta work often possesses a spirit and vigor which can hardly be reproduced in the laboriously finished marble. It has of late years been very largely used in some important buildings in different places all over this country.

The great improvements which have been made in the manufacture of terra cotta will quite likely lead to its more extensive use. The great difficulty has been to retain the impression of the mold in all its sharpness of outline and detail. This is due to the uneven shrinkage and warping, which is likely to occur in the manufacture of large pieces; the outside, or edges and corners, dry faster than the middle and under side, and in consequence of the slow drying of the middle, its shrinkage is greater, thereby destroying the beauty of its lines, as any want of truth in architectural lines soon become painfully apparent to the true artist. This is more noticeable in long lines of cornice, or in the fit of an arch of door or window, belt courses, or entablatures, etc., each piece must fit accurately to the next one, or else the lines of molding become broken and irregular, thereby defacing what it was intended to render ornate.

Terra cotta is now made of many different colors; some manufacturers using a clay to correspond with their pressed and ornamental bricks, which they manufacture in connection with it—a rich red and a warm ochre or cream color, being the most pleasant to the eye, and more in demand.

In order to avoid the defects of making in its warping, twisting, shrinkage, or cracking and breaking when it is fired in large

pieces, it is necessary to have a large proportion of silicon in the clay; and most manufacturers wash their clay, to remove any impurities in the way of sand or fine pebbles of stone or iron. And it is usually stored up months in advance of using, to allow it to become seasoned and make a homogeneous mass when it is finally worked.

CHAPTER XX.

WOOD AS FUEL IN BRICK BURNING.

The time is not very remote when there was but one kind of fuel used in burning bricks. Forty years ago, I believe I am sure in saying, there was scarcely any brick burned except with wood; and those with the old style out of door kilns; while to-day we use wood, coal, coke, natural gas, or oil, in permanent kiln walls, or improved patent kilns, with furnaces attached, constructed on scientific principles. Wood and coal being more generally distributed over the brick manufacturing districts, are more largely used, and in all probability will be for years to come.

When this country was in its infancy, it was covered in great part with a dense growth of forest, which usually occupied the best of our arable lands; wood was then plenty, and every means was employed to rid the ground of this surplus timber; and among other things was the utilizing it so far as possible in brick burning. And even to-day in some sections where there are tracts of timber a little remote from market, you may hear men speculating as to the advisability of using this wood, to burn a kiln or two of bricks. They say "I can't sell the wood and I have great lots of it going to waste; and I believe if I would use it up and burn a few hundred thousand brick I could sell them some time, even out here in the country." And in many places where wood was less salable than brick, it was the starting point of

some of our prominent brick manufacturers; making available and profitable to themselves their otherwise useless materials.

Wood in most places is being rapidly superceded by coal, wholly or in part, and for several reasons. First on account of its scarcity, which in turn makes it high in price. Wood that has hitherto made the best fuel is no longer used as such, because of its value in manufactures in various ways. Where trees were cut entirely up into cord wood in former years they are now first cut for sawmill material, and all the trunks and solid parts are used as such, while the top limbs and inferior parts, together with dead hollow trees are worked up into cord wood; so that no great quantity of first class cord wood is available now as formerly. The comparative value of wood in comparison with coal, depends measurably upon the kind of wood, or the time it was cut, condition and quality generally.

The following table gives the value of wood as fuel as compared with coal in weight:

One cord of hickory or hard maple weighs 4,500 lbs., which is equal to 2,000 lbs. of coal.

One cord of white oak weighs 3,500 lbs., which is equal to 1,750 lbs. of coal.

One cord of beech, red oak and black oak weighs 3,250 lbs., which is equal to 1,450 lbs. of coal.

One cord of poplar, chestnut and elm weighs 2,350 lbs. which equals 1,050 lbs. of coal.

One cord of pine, weighs 2.000 lbs., which is equal to 925 lbs. of coal.

So it is safe to assume that 2¼ lbs. of wood equals 1 lb. of the average quality of bituminous coal; and 1 lb. of pine wood is worth about the same as 1 lb. of hickory, assuming both to be dry; and in brick burning it is very important that the wood

be dry, as each 10 per cent. of moisture will detract that much from its full value.

Wood should be cut and seasoned not less than six months before using; and should be split into sections so as to be handled readily, and enter the arches without unnecessary effort or struggles of the fireman.

Where the wood is split or left in large, ungainly knots, or forks of trees, firemen will usually work around them or away from them, leaving them on hand and in the way when done burning the kiln; and in this way a large lot of worthless wood is liable to accumulate.

Sometimes wood that is cut and "ricked" up in the woods, remains there for a term of seasons and deteriorates very much in value as a fuel. It may be the trees were of a variety that have no lasting quality, and the sap portion of the timber is soft and spongy, and rots easily. Such wood makes but little heat, by producing but little flame, and is no more than a smoldering bed of coals.

The same would be true of other varieties of timber cut at the wrong time of the year, as then the worms would have so eaten and penetrated all the sap portion beneath the bark, and not stopping there but attacked the hard wood beneath the sap, and in a measure destroyed all of it, enough so as to render it nearly worthless. If the fuel is good the intelligent burner knows it; if it is not he must work accordingly. Any of the free burning woods, sound, hard, and dry, is what is needed for fuel when you use wood.

But do not expect your burner to do good work with green wood, or that which is sap rotten; or sour heavy, stuff that will not burn free in any condition; or a lot of small twigs and brushy stuff that may have been imposed upon you as cord wood.

As a rule, brick can be burned at the rate of two thousand to

the cord of wood; and the man who makes from one to four millions of brick annually, has a grave problem before him in the early spring months.

He must have his fuel on the yard at all times, when he does not need it, as well as when he does; and many times during the season will find him short of fuel, and a kiln hot. Some of the old brickmakers will smile and say "I have been right there myself."

And again, wood is a bulky fuel; it occupies too much space that in most yards is valuable, and on account of its bulk and inflamable character, must be kept at a reasonable distance from burning kilns.

Now consider the bulk of wood necessary to burn four millions of brick, at the above estimate. It would require a rick of wood, four feet wide, eight feet high, and a mile and a half in length. This is only a reasonable approximate estimate; some will say, too much, others not enough; but is based on experience and observation among the brickmakers over a wide extent of country.

I hear it frequently stated that there is a great difference in the burning or refractory properties of clay; but I find a greater difference in the fuel value of wood from one pile to another, than I do in the clay banks from one yard to another.

The woods of the Northern States are harder, tougher, and of more lasting quality, and make better fuel as a rule than the timber of the South, excepting only the rich, fat pine of the Southern States.

Taking varieties as they run; white oak, beech, maple, hickory, post oak, ash, etc., and the growth is a hard, tough timber, making a hot, lasting fire; while the native woods of the South, many of them, are among the soft woods, or lighter timber, such as soft maple, cotton wood, magnolia, cypress, cedar, chestnut,

elm, sweet gum, etc., and among the varieties of oak and hickory, the timber is not so dense or lasting in its quality as a fuel.

Over a great portion of the Southern States, there is an abundance of good pine; but like all other sections where brick are most in demand, the timber is getting scarce, and first class pine cord wood is scarce; and pine wood can only be had from the second growth timber, designated "Old Field Pine."

CHAPTER XXI.

COAL AND ITS VALUE AS A FUEL IN BRICK BURNING.

What has been said in a preceding chapter in regard to the difference in value of wood, is applicable also to coal. The coal measures are distributed over a large area of the inhabited part of the earth's surface, and any part that is inhabited by civilized peoples in the alluvial districts, which is void of coal, is still largely dependent upon coal for some of its uses in the arts and manufactures.

It is found upon analysis, and also more clearly demonstrated by practical tests, that coal varies very much in its constituents, and as a heat producer. The coals classed in market as Muskingum Valley coal, Brier Hill coal, or Pittsburg coal, has no uniformity of grade, and varies from good to bad in different mines of the several districts, and so it is through all the different coal measures of the different states and sections.

Geologists teach us that the Brown coals, or lignite, are examples of imperfect coal, or what is termed coal of recent formation. This is loose in texture, soft, dirty, and produces a low heat, with a large proportion of ashes and refuse.

The bituminous coal fields of most sections, have some mines that approach this quality of coal; particularly where the coal lies near the surface, or crops out on hill sides or in ravines or bottoms of streams; that which lies deeper in the earth being

more pure, or perfect coal. In this grade of pure or perfect coal, the combustible matter is part fixed, and part volatile.

When the combustible matter contains from 90 to 95 per cent. fixed carbon, it is called anthracite coal. If it contains from 80 to 85 per cent. fixed carbon, and 15 to 20 per cent. volatile matter, it is called semi-anthracite or semi-bituminous coal, of various grades.

If the volatile matter rises to the proportion of 30 or 40 per cent., it becomes full bituminous coal, which always burns with a strong, clear flame, and will cake over or melt together into a mass, and when the flame has passed off, will burn as coke, with an intense white heat, melting the solid ashes into a cinder or clinker.

If the coal approaches or exceeds 50 per cent. volatile matter, it is highly bituminous, fat or fusing coal, and is well adapted to the manufacture of coke, gas, oil, etc. Now after careful comparison of different coals, it is evident there must be a great difference in results in brick burning, in using the different varieties of coal.

I am frequently asked "How much coal does it take to burn a thousand brick by your method?" Now that is a question that I will answer and do it as near correct as the man who will tell me "How much milk a cow gives, or how much does a lump of chalk weigh?"

I have frequently been interviewed by men who are interested in railroads, as road masters, master mechanics, engineers, (C. E.,) etc., and they also had a smattering knowledge of, and controlling interest in a brickyard. These men had their locomotives to do a stated amount of work in a certain length of time, with a regular allowance of coal, all figured out and tabulated, by rules and problems in Engineering and Physics; and they did not hesitate to tell me that a man who could not tell how much

coal it took to burn a thousand brick was not fully up to the head in his class as a brick burner.

This article is to answer that class of brickmakers. When an engineer is confined strictly to one grade of fuel, each engineer his own engine, and one route of travel regularly, and his load never exceeds a certain number of loaded cars, he can then tell very nearly how much coal will be needed to make the trip.

But with the poor brick burner, the case is an entirely different one. He has no means of knowing how much moisture has to be expelled from his green brick before they are burned. Sometimes his fuel is from one mine which is a free burning, fat coal and again it is from another mine which is dirty, full of slate and sulphur and altogether is a poor fuel.

One time his fuel is slack or coal refuse, and another time it is nut coal of fair quality, or during a scarcity of this grade he has run of mine. In my own case, I have had the best nut coal to raise heat immediately after the water-smoke was off, and then be compelled to use a poor quality of coal dust, with a settling heat and finish. Our engineer will say, "Why do you have it so? Why don't you use a uniform quality of coal?" "Well," I answer, "I have found that railroads and brickyards are, of a necessity, compelled to run business in two entirely different channels. The financial standing of the two is so wide apart, they can't be run together on the same rules and principles.

And, again, it is a conceded fact that clays vary in their refractory properties, so that the man who burns fire brick will use 1¼ tons of coal to the thousand, while on the yard next to him, where common red brick are burned, the same amount of coal will burn four or five thousand brick. And all brickmakers of experience who are up to their business know that their clay will vary in the bank, and must be mined, mixed, piled, and

mixed again in proportional amounts from different parts of the pit, to secure a uniform grade of burned brick.

This argument is to show that there is no exact rule, and can be none, for pounds of coal or wood as a heat producer, to the thousand of burned brick; and there are also various other reasons that can be assigned, which will remain always among the undemonstrable problems of brick burning.

Block coal as it is mined comes to market in large lumps, partaking the nature or appearance of slate, that can be split into slabs or sections,and is not liable to fall to pieces in handling. While it is a free burning fuel, it leaves a large quantity of loose, light colored ashes, and on account of its large size and hardness in breaking,it is not desirable as a fuel for brick burning. Coal that is used for burning brick should be of a small size, so as to scatter evenly over the grate bars, and begin to make heat rapidly. Block or lump coal can be used in its coarse condition as mined in blast furnace work; but for brick burning the best success is attained with nut coal, and coarse grades of slack, or coal screenings.

The experience of the writer is, that the very best coal to produce heat with free burning qualities,freedom from excessive clinkers, a low per cent. of sulphur or slate, is that from the mines of East Tennessee. While there are other sections that produce a good quality of bituminous coal that may be equally as good or even better, our observation among the coals of Northern Ohio, Western Pennsylvania, Illinois, Indiana, Missouri, Virginia, Alabame, Georgia and Tennessee, goes to prove that, all things considered, we give it precedence over the others.

The Virginia coal mined on the line of the Norfolk and Western Railroad, and classed as Pochahontas coal is a bright, glossy, bituminous coal, or as some call it, semi-bituminous. This coal is of a free burning nature, but is not productive of

much flame; rather too much sulphur, and makes a large amount of heavy clinkers. The lumps of coal are readily shivered or knocked to pieces with a light blow of a hammer. The one great fault of a coal of this kind is, it breaks up too fine, and when "fired" the fuel lies so close on the grate bars, as to virtually close all draft through them. This is one cause of its liability to clinker. The heat goes over the top of the mass, causing a melting together of half burned coals, which cool on the dark ashes below. This coal is so fine and free in parting into dust, than when shoveled into a superheated furnace, the particles will ignite with a flash like powder and cause an instantaneous rebound of the fire from the furnace door.

It is not the intention to write up the coal of any locality, or deprecate another, but merely to compare the value of the different kinds of coal, and show that manufacturers of brick and clay wares have a different problem before them, than the man who uses coal to raise steam in his boiler, or to make heat for domestic use, or any other of the uses to which coal is applied.

Take, for instance, the anthracite coal of Pennsylvania, and for cleanliness, evenness in burning, lasting qualities and freedom from sulphur, or any other deleterious substance, and for domestic use, it can scarcely be excelled as a fuel; certainly not for cheapness and unlimited quantity. But we must question its use as a fuel in brick burning, for the reason that it has but little flame, and is virtually slower of draft, consuming more time to burn.

Again, it is of a smooth, or slick nature, which is enhanced when brought to a red heat, and has no coherence one particle to another, which allows it to part with all of its fine coal, by slipping through very fine grate bars into the ash pit, thereby causing waste, while bituminous coal will part with its tar or oily components, and cause it to expand and coke over the grate bars, which can then be rustled up with the firing iron, while the flame

carries the heat high up in the kiln, and causes hard brick to be burned at the top or near the platting courses.

In burning brick with coal, it is always best to drive off all the moisture first with wood or coke before putting on the coal fire; there being a tendency in most kinds of bituminous coal to produce a large amount of heavy smoke and soot that clings to the damp brick at the top part of the kiln, and retards the draft, or as brick burners say "chokes the kiln," and can only be driven off by long continued firing with coal or, what is quicker and a better plan in such cases is, to stop coal firing and fire with wood until red heat is well up over the kiln.

Coal has the reputation of burning brick a darker color than with wood. This may be true, but my belief is, that coal furnishes a steadier heat, and where coal is used there is a better provision for brick burning, control of fires, less of cold air admitted among the heated burning bricks, and as a result, the bricks are more uniform in color, are not blued or shaded by cold air drafts, and have their true color. This is more marked in the improved kilns of modern design than the old clamp walls.

An opinion prevails among a great many brickmakers, that coal cannot be used for brick burning without furnaces and grate bars, and they go on from year to year using wood alone, at a high price, in the sections where coal is abundant and cheap. We will give our observation and experience in the matter, which can easily be verified. Where you desire to burn brick in part with coal, you begin first by setting your arches, twelve inches wide, three and a third brick bench, set nine courses high with four overhanging courses; this makes the arch high enough to build your fire holes, two to each arch at each end of the arch.

First build the lower one outside, three bricks in length, four courses high, and arch them over. On top of this arch lay any heavy iron bar. An old railroad iron is about as easy procured

and suitable as can be had, laid next to the kiln and crossing all the arches. This bar serves as a bearing for cord wood to lean on when firing. Now level up on top of the arches, and fill in carefully between all the buttresses, and turn another arch immediately over the one below, and of the same size.

In water-smoking the kiln, fire altogether in the lower arch next to heads, and as the kiln gets hot and dry, in the upper one with wood only. Then when you have draft enough in the kiln to burn freely, slide in two sticks of wood in each arch, letting the ends rest on the inner iron bar. On top of this wood shovel in coal until the upper arch is closed, and the draft through the lower arch will cause the coal to burn free.

The lower arch must be kept clear and bright, clinkers pulled out and all draft to be through a bed of free burning coals. At each recurring fire, shove in the coal with your two sticks of wood in the upper arch; then fire the coal on top of them as before. When it is necessary, the arches can be fired by sliding wood to center as in any old style kiln. In this way a good heat can be produced, and the fuel bill very much shortened. Lump coal or run of mine, is the kind to use, as coal that is fine requires grate bars. While there is some advantage in this method over wood alone, where coal is plenty and cheap, we do not desire to be understood as recommending it. Our preference is for permanent kiln walls, and furnaces.

Where kilns are properly constructed and managed, and three arches are burned with one fire, there is a great saving in fuel, labor, and wastage of brick; permanent kilns are plenty enough at this day, so there is no controverting the fact, and they are designed to burn wood, coal, gas or oil, according to your location.

CHAPTER XXII.

FIRE CLAYS AND FIRE BRICKS.

While we have said but little or nothing so far about fire bricks, this manual being prepared chiefly for the use of makers of red or building bricks, yet we feel that the work would be incomplete without it, and the importance of that line of brick-making demands that we should add a chapter devoted to that subject; and under the head of fire brick we will include paving brick, as an addition to the chapter, as these goods are, at present, coming into prominence along with the other branches of the clay industry.

We have frequently been amused, and at times have been beset, by parties who made a discovery on land belonging to them or in which they had an interest, of a clay which differed in texture, color, plasticity, depth, etc., from anything in the line of clay of which they had any knowledge, and the idea was uppermost in their minds that they were possessed of a mine of wealth, if they could only induce some party to look into the matter and locate a works to make pottery, tile, sewer pipe, earthen-ware, fancy bricks, terra-cotta, etc. In their opinion, anything and everything in clay ware, from bricks to finest porcelain, could be made of it if they could only find the right man to lay hold of the enterprise and make them rich with the products of their find; and it has been the duty or task of the writer when called upon for his opinion as to the value of some of these clays, to pronounce

some of them a very poor quality of clay for any manufacturing purpose, the tests being made in the mold, in drying, and lastly in burning them, which is the crucial test for all clays.

Most of these enthusiasts would adopt the idea that their find was a valuable deposit of fire clay and their hopes were built on working it up by making fire brick at a price ranging from eighteen to thirty dollars per thousand for the product and the profits counted as all in excess of making a common rough, red brick, when, in fact, it was usually farther from being a fire clay than some other variety, not having any properties that would resist fire and would generally melt like a wax and form a vitreous mass under a heat that would only burn hard a good, red brick clay. This, to many of these parties, was a sad blow to their hopes, or a signal for an attack on the veracity or knowledge and skill of the party or parties making the tests and experiments, but in every case of the kind spoken of, we know those beds of clay still remain undeveloped mines of wealth.

While good fire clays are abundant, there still remains a great deal of ignorance in that line as to the properties of a fire clay. What is usually used for making fire bricks is not a plastic, free clay, properly speaking, but is found between the veins or seams, or below the coal in the coal measures. It is of a dark gray, or grayish yellow color; approaching a black or brown, with a slaty or rocky nature, that dissolves on exposure to the weather; or it is rendered plastic by grinding in pans, crushing with rolls, or other pulverizing machinery.

Most fire clays are blended in the process of manufacture, to obtain the best results; some being deficient in silica, or lime, or some one or more of its constituents. Very few clays can be used as dug or mined. Most of the refractory clays are deficient in infusible matter, and must have it supplied and incorporated with the plastic clay. This is furnished in quartz sand, pulverized

flint, burnt clay, or granulated fire brick bats, serpentine, talc, graphite in powder, etc., etc. This is mixed in the proportion of plastic clay one-fifth, and of the refractory or infusible matter four-fifths, or one-fourth lean, and three-fourths burnt clay, or quartz. This is done to prevent shrinkage, as it is highly important that all furnace work remains in place where laid without shrinkage; as usually there is a part of the superstructure of the furnace, resting on the heated brick work below.

A friable paste with large grains, will resist a great heat and remain unchanged, while one with fine grains and not well mixed will split at a high heat, or will melt and warp. All fire clays are not obtained in the coal measures; there are many places where excellent fire clay is found in abundance as a natural compound and in proper proportion to use as dug from the earth, containing a good combination of silex and aluminum, with enough of lime, or iron, to properly fuse or flux the mass in burning. There is a clay of this description in South Carolina that makes a good fire brick for all ordinary purposes, standing up well under a high heat. But, like many other sections so favored, it is remote from market or lines of transportation, making it undesirable.

Fire bricks and all fire clay goods, are made of the most infusible clay obtainable; such as contain from 63 per cent. to 80 per cent. of silica, with the addition of from 18 per cent. to 25 per cent. of aluminum to render the mass plastic; the remainder is water and contains besides, in small quantities, lime, soda, magnesia and iron, with traces of potash. These latter ingredients cause the clay to flux under a high heat and form the burnt brick. When the clay contains from 6 per cent. to 10 per cent. of these fluxes it will generally melt. If the silica is largely in excess, 3 per cent. or 4 per cent. will cause it to melt. If it is aluminous, 6 per cent. or 7 per cent. oxide of iron will not cause it to loose its refractory qualities.

The essential qualities of a good fire brick are, first, uniformity, and by this is meant, not in size alone, but in their composition. The clays and infusible material must be so evenly blended, that they are alike in the materials of which they are made. A fire brick is not like a common building brick which has apparently no other office to fulfill than to uphold the superstructure above it. The fire brick is required to do this and also stand up under a heat that tends to melt, or a blast from forge or bellows, that has an abrading or cutting force, similar to a blow pipe on the fire within the furnace, and if any part of the furnace lining is deficient in infusible material, there is a weakening of the wall at that point. By uniformity also is meant size as mentioned above. The principal trouble experienced in all fire brick work is in the work of the brick mason; he usually makes too open a joint between the bricks, and much of the mortar used in construction is not of the same nature as the fire bricks; generally being made of a low grade of potter's clay, or some other soft unctuous clay found in the neighborhood, and miscalled fire clay. This is used in a manner that is entirely wrong for this class of work. It is made up of about the consistency of lime, mortar and sand for plasterer's use. The clay is not well tempered, is full of lumps of stiff mud; probably half the clay has been dissolved that was meant to be used; the remainder is scattered throughout the mass, like raisins in a plum pudding. The mason uses this mortar, as he did lime mortar, with a joint of one-fourth or three-eighths of an inch between bricks, and when the work is completed it is usually in a good condition to shrink a considerable in drying, before the fire is applied to the furnace. Such clays as this mortar is made of, have a great tendency to shrink or melt under a high heat, and when the furnace becomes superheated, the mortar joint is the first place to give way; the fire cuts into the opening where the mortar has melted out, forming eddies

of flame, which is sure to destroy or deface the inside of a furnace wall, and when it is cut deep enough to throw the weight or part of it on the heated bricks, they begin to warp, twist, and eventually fall out.

The only sure remedy for this is to make very close joints in all fire brick work. A paste or mortar made of finely ground fire clay, or pulverized fire brick bats, is the best; mixed thin so the bricks can be lightly dipped in the paste, and then quickly put in place, rubbing and settling them down to a close bed, both on the sides and ends. The bricks are better to be wetted before dipping in the mortar, as that prevents them from setting their mortar bond too quickly till put into place.

The third requisite of a good fire brick is strength to resist the different pressures required of it, under different circumstances. The crushing weight of a fire brick is from 600 to 1000 lbs. to the cubic inch. Some of the best grades of fire brick have been known to resist a pressure of 3,000 lbs. and upwards. To insure safety, they should support more than double their own strain under a long continued high heat without attention. For the walls of a furnace, the best bricks are close grained and dense, that have been burned in their manufacture enough to take out all shrinkage, and contain in their composition an excess of silica. In the hearth of the furnace they should have an excess of alumina; in the walls and arches exposed to the abrasion of the flames, ashes and cinders, together with the action of acids or alkalies contained in the fuel, or contents of the furnace, the bricks should be nearly pure silica, with a proper modicum of alumina and magnesia. A good fire brick will wear or burn off evenly, without melting to excess, chipping or splintering. The wear of the brick is caused by the flames and dust; chipping and splintering, by the expansion and contraction from cold to hot, and hot to cold, when the fires are allowed to go down and the furnace cools

off. The best fire brick should be of a pale cream or clear buff color and uniform throughout its mass, when burnt to the full extent of its shrinkage.

The fourth requisite for a fire brick is its cheapness, and there is no material yet manufactured that fulfills all these conditions perfectly. If the clays are deficient in any part of their composition, supplying the deficiency adds to the cost of making; or the clays are remote from the market, and transportation adds to the cost of them. Oxide of iron when present in the clay will show itself in gray or cinder spots, and blotches on the burnt brick, and more or less, according to the percentage of iron. A light colored cream or buff brick, denotes the absence of iron; and lime is the agent which fluxed the mass in burning, any excess of lime making it fusible. The most refractory clay when deprived of its water, is silica 57.42, alumina 42.58. Silica alone cannot be used, as it has no binding qualities like alumina.

Almost all sand stones contain a small per cent. of clay or lime, that cements the particles into a solid rock. Some makers of fire brick use sand-stone by burning it, if it is what is called a quartzose sand-stone. It is then cooled with water which aids in its disintegration; ground lime is then added in the proportion of 1½ per cent. both in the bond or plastic clay, and also the mortar in which they are laid.

Fire bricks require a much greater degree of heat to fuse or burn them ready for the trade than building bricks. It is estimated by tests made with the pyrometer that red brick will fuse at from 1,200° of heat to 1,500° in most clays, while with fire clay it requires from 3,500° to 4,280° Fahr. to burn them.

Fire clay goods are usually burned in what are termed, up and down draft kilns, with arched over tops, to prevent the too rapid escape of heat, and pressure of the atmosphere from above while burning. Others use kilns of a circular shape with arch

turned over at a height of ten or twelve feet from the floor, and the kiln is carried on up to the height of from forty to sixty feet, and gradually narrowed down to from four to six feet, for the top of chimney. Openings are left in the crown over the kiln for the escape of smoke and vapor, and as the kiln becomes hot they are closed down to a small vent, and the heat is condensed and held on the ware in the bottom of the kiln. These kilns have a door in the side for filling and discharging, which is sealed up close when the kiln is full. The capacity of a fire brick kiln varies from 6,000 or 8,000, on up to about 35,000 for the largest sized kilns. These kilns, with the arch inside of stack are up draft kilns or more commonly styled direct up draft, or muffle kilns.

We have occasionally made some very good fire brick for our own use in the following manner: On a large works, there are always more or less of an accumulation of old worn out fire bricks and bats—by placing these on a solid pavement of hard brick, and crushing them up fine with a heavy iron tamp, so they can be screened through a ¼ inch screen. There is in almost all neighborhoods a vein of tough clay of the consistence of potter's clay, such as was spoken of in the fore part of this chapter. By mixing this with the crushed fire brick in the proportion of two bushels of clay, two of crushed brick and one of sharp sand, the raw clay serving for a binder, then molding them on the machine, after first moistening the mass sufficiently so it will work properly. After thoroughly drying them, we set them in the top part of the arches and overhangers, under the red brick, where they will get the hottest fire of the burn.

Where works require a large amount of fire bricks, and the purchasing price is from twenty to thirty dollars per thousand this will effect quite a saving. Any one having an accumulation of fire bricks and bats, can secure a very common grade of fire or potter's clay to use as a binder. We do not desire to be understood

as saying that these brick are good enough for all fire brick work; but that they will answer well for almost all walls and arches that are not subjected to a very great degree of heat. There are parts of all furnace work that require the best brick that can be procured, and it is economy to get them even at a high price, rather than have the furnace give way at an important point, while the furnace is heated, in the midst of an important piece of work, as the burning of a kiln of brick.

The following we copy from the *American Mechanical Dictionary:*

Fire bricks are usually made of silica, and refractory clay, with a small proportion of cementing material. Some fire bricks are made into which clay does not enter as an ingredient.

In England quartz is ground, and freed from iron by sulphuric acid. In Wales fire bricks are made of ground quartz with one per cent. of lime, and water sufficient. The bricks are made in iron molds by pressure, and in burning the lime acts a flux to cement the quartz.

The composition of fire bricks is indicated by three analyses, at widely different points, first:

CARTER COUNTY, KENTUCKY, CLAY.

Silica	45 to 64
Alumina	23 " 43
Oxide of iron	a trace
Lime	" "
Potash	0.212 to 2.093
Soda	0.283 " 0.728

BELGIAN FIRE CLAY.

Silica	64.2
Alumina	32.2
Oxide of iron	2.4
Lime	0.0
Alkalies	1.2

The fire clays of Forges les Eaux, and Ardennes in France, Belgium, Stourbridge, England, and Klingenberg, Germany, vary between the following proportions:

Silica	64 to 71.
Alumina	22 " 38.
Oxide of iron	0.2 " 4.
Lime	trace " 1.
Alkalies	" " 1.

The following extract is from *Ure's Dictionary of Arts:*

FIRE CLAY.—Fire clay is found in great abundance and perfection for making fire bricks, retorts, etc., in slate clay. In color it is gray, or grayish yellow; massive, dull, or glimmering, from admixture of particles of mica; fracture—slaty, approaching some times to earthy; fragments—tabular, soft, sectile, and easily broken; specific gravity=2.6; adheres to the tongue, and breaks down in water. It occurs along with pit coal. Slate clay is ground, and reduced into a paste with water for making fire bricks; for which purpose it should be as free as possible from lime and iron. Pure clay, the alumina of the chemist, is absolutely infusible; but when subjected to the fire of a porcelain kiln, it contracts into about one half its total bulk. It must however be heated very cautiously; otherwise it will decrepitate, and fly in pieces, owing to sudden expansion into steam of the water combined with its particles which it retains with considerable attractive force. It possesses little plasticity and consequently affords a very short paste, which is apt to crack when kneaded into a cake. It is not infusible by itself, but it will not dissolve in the fusible glasses; making them merely opaque. If either lime or silica be added separately to pure clay in any proportion, the mixture will not melt in the most violent furnace; but if alumina, lime and silica be mixed together, the whole melts, and the more readily, the nearer the mixture approaches the following mixture or pro-

portion: 1 of aluminum, 1 of lime, and 3 of sand; if the sand be increased to five parts, the compound becomes infusible. These interesting facts, show the reciprocal action of those earths which are mixed most commonly in nature with alumina.

We cannot close this chapter without adding a word of caution, which we extract from the writings of Professor R. T. Brown, of Indianapolis, formerly Chemist of the Department of Agriculture, Washington, D. C. He says: "The analysis of a clay is only *presumptive* evidence of its adaptation to the various departments of clayworking, and never to be taken as conclusive. The intense heat of the kiln may effect decompositions, and develop combinations which are beyond the reach of chemical regents. The presence of a great mass of highly heated material, sometimes exerts an influence that cannot be produced in the laboratory. These remarks may be prejudicial to my profession, and indeed uncalled for, but they are the honest truth."

PAVING BRICK.

Within the last few years there has been quite an agitation created in the minds of municipal authorities, as well as among the citizens, in regard to street pavements, with all the improvements made in our means of locomotion, carriages, cars, etc. The fact still remained with us that our streets were very imperfect; they were out of repair, rough, dirty, and withal were expensive to construct, and troublesome to keep in repair. The demand is almost universal among the cities that make any pretensions of keeping up with the improvements of the times, for better streets. This demand must be met with a material that is suitable for all localities, and make a better roadway than any other now in use.

Almost all sections have a material that will answer as a substitute, and make a roadway better than the soil or clay of the neighborhood. Many sections are well situated in respect to rock, or gravel. This spread upon the street to form a heavy bed or

foundation, will stand the wear of vehicles for some months, and makes a passable roadway, but is all the time being ground into powder, and this makes dust when the wind blows, or mud when it rains. There has been no move made toward a general or universal road material,except as brick or paving blocks are coming into general use. Granite blocks are in use in many places,and make a good street; one that will stand an immense amount of wear, is clean and moderately smooth. The cost of granite is what will hinder its coming into general use, as all are not so well situated as to have granite quarries, and when transportation is added to the first cost, makes it beyond the reach of even rich corporations. Brick for street paving can be made in almost all localities or near by; as clay is so abundant and generally distributed that but few places are situated so that there is no clay of some kind suitable for good brick.

It is not all clay that will make a first class paver. There is an abundance of clay that will make a No. 1 building brick, that has not the requisite toughness or plasticity to make a strong, compact brick, that has a clear metallic ring like a piece of pottery. The clay should be put through a thorough process of tempering, kneading and working, so as to make the mass of clay a compact, homogeneous mass. The toughest, strongest brick are those made on a stiff mud machine, as stiff as can be conveniently worked; then dried slowly and evenly; and thoroughly burned to the proper degree of hardness. A brick that is made from a coarse clay, or one that has a large per cent. of sand in it, will be open and porous, or easily broken, and is unfit for paving purposes. The ideal paving brick is one that is made as described above from a tough, plastic, smooth clay, with a fine grain; that will burn hard without warping, twisting, or melting easily under a strong heat, as the brick must be made to lay a smooth, even floor, or pavement, and be hard enough to be non-absorbent of

fluids. It has been sixteen years or more since the first brick street pavement was laid in the town of Charleston, W. Va., and it was brought to the notice of the city authorities by the brickmakers, as a suitable material, in lieu of macadam, or other paving material.

Extensive and thorough tests have been made since then, almost altogether by brickmakers themselves, as was the case in Charleston; they going so far as to furnish the material and grade the street properly, and put down the pavement at their own expense, on a section of the street that was subjected to a great deal of travel and heavy traffic.

The wiseacres shook their heads ominously at this move, and were profuse in their predictions of failure. These streets proved in every case to be the very best in point of comfort, durability, convenience or easiness in keeping in repair; and what is over and above all, the cost was below that of granite or wooden pavements, or any other good paving material. This piece of pavement was in constant use for eleven years, and was then in a good state, showing no signs of failure or wear, and was taken up to allow of the street being properly graded; the authorities in the mean time having put down some miles of brick pavement on all their streets having heavy wear.

The system is gradually coming into use and spreading; particularly into sections of country that are void of rock, like the prairie country of Illinois, and which is blessed with an abundance of clay suitable in every respect for paving bricks. These flat, prairie countries stand in need of some cheap, durable pavement, as without it they are left in a miserable condition during part of the fall and spring months, and wet seasons.

The cost of brick pavement, including the grading and all necessary work to complete the same, will vary from $1 to $1.80 per square yard, according to the location and price of labor,

teams, sand, etc., and it has been demonstrated that streets can be paved, including curbing and sidewalks, together with the necessary grading, at a cost of $2 per yard, where labor was $1.60 per day, teams $3.25, and sand 80 to 90 cents per cubic yard.

There are a great many localities all over the country, that have excellent beds of clay suitable for paving brick; and brickmakers should be taking advantage of these opportunities to secure them, for the trade which is sure to come; as the durability and economy of this kind of roadway has been amply demonstrated. There is one thing we will as a body of brickmakers have to do, that is: Take some measures to call the attention of civil engineers to the fact of brick pavements being superior to stone, wood, macadam, nicholson, asphaltum, or any other of the recognized good paving materials, which are in use over the country.

We have endeavored to get what information we could on this subject, by inquiry and examination, and investigating the kinds and qualities of different clays, bricks, and pavements; and after all, we do not think we can add anything to what has already been said on the subject. The universal opinion among brickmakers, who are interested in paving brick is, that a brick for paving purposes, must be burned hard, almost melted, or vitrified.; a brick that is not burned to this hardness, should not go into street work.

In burning brick for building purposes from a good, tough, unctuous clay, very often there is quite a large per cent. of bricks in the arches that are burned to the proper degree of hardness for pavers. These should be selected and set aside for that particular purpose and then when you have accumulated enough to do so, make some arrangements with your city officers to put down a small section, where it will get the constant wear and traffic of the street continuously. See that the work is well done—none but good brick put in—and then call the attention of the authorities

to it and request them to examine it carefully and compare with other pavements.

Showing section of street and sidewalk construction.

There are several methods of construction of streets with paving bricks which have been adopted by different cities, according to their ability and inclination, and with varying degrees of success. The first plan was to grade the street to the proper degree, leaving it from five to seven inches higher in the middle; then put down from two to four inches of coarse sand and fine gravel; bring it to a proper curve with a template, and then roll it with a heavy roller until it is firm and hard; on this lay the paving brick on edge, and at right angles to the sidewalk. When it is all down, sand should be scattered over it and left there until it is well settled down between the bricks, and has filled all the spaces. This is the cheapest plan, but is not the best, as the ground beneath is likely to become softened, and the bricks driven down by heavy vehicles, making holes and ruts. One way to remedy this, is to lay a course of bricks on their flat side on top of the coat of sand; then on top of these bricks, put sand enough to bring all even with the template again, and pave on this with bricks set on edge; or what is still better, grade the road way, five or six inches deeper and fill in with broken rock and sand, or coarse gravel, furnace slag, or cinders, with sand; this must be rolled or rammed hard, and over this put down the two courses of brick as described above.

Another plan known as the Hale pavement system, is to bring the street to proper grade with a covering of about three inches of sand, all made smooth and surfaced with the template; over this is laid lengthwise of the street a covering of one inch

boards, which have been steeped in hot tar; on top of these boards is again spread an inch or two of sand, and spread smooth as before; and on this, brick are laid on edge, with fine sand swept into the spaces between the brick. It is claimed that this last pavement is much cheaper than the double course of brick, or broken stone and sand; and the boards below give a good bearing for the brick and prevent their driving down into the sand or soil. This system is patented, and has been in use on some few streets for several years with excellent results.

HINTS TO THE BEGINNER.

*BY J. A. REEP.

In starting a new brick plant fitted up with modern improvements, as a summer and winter yard, there are probably as many main points to take into consideration, to insure success as in any other of the principal lines of manufacture.

Most new firms about to engage in the manufacture of bricks are likely to flatter themselves on the simplicity of the business, and its few requirements, and consequent small outlay of capital.

The points that are to be considered are situation, suitable material, fuel, labor, water supply, market, and proximity to city. These are some of the main points to look after; some of these can be so managed, as to overcome any possibilily of entire failure, but the plant may struggle along in a half-handed way for a long time and be paying a low rate of interest on the investment. For instance, the situation in every other respect may be good, and the clay although abundant, may be of such a a nature that no known method of making and burning could produce from it brick that are desirable in color; and you would be compelled to make nothing but a common rough brick of per-

*NOTE.—The above paper was read before the National Brick Manufacturers' Association, at Philadelphia, Pa., the Fourth Annual Convention, which convened Dec. 10th, 11th and 12th, 1889. While there are many points in the address that are in the body of this work, yet there is much of it that will appear as new material, and will bear repeating here as a work to refer to at any time by those contemplating the starting of new works in the future.

haps an inferior quality, and sell them at a low price to realize anything.

In starting a brick plant first be sure of a market for your bricks. Have a clay bank ample enough to last as long as you desire with a growing trade. Never build large and expensive works on a shallow bed of poor clay. See that you have a good location for your works above high water mark; good drainage in every respect about your works; water supply ample enough for all purposes—for steam and tempering of clay, for drinking and in case of fire.

Locate yourself convenient to some good line of travel and shipment, either by boat or railroad; if you depend on water lines provide yourself with your own boats or barges; if by rail, establish yourself permanently as regards your shipping rates, both for fuel and bricks, or as near it as you can in reason. Get "elbow room." Make a complete plan of your works before you begin, then carry out your plan to completion. Let it be arranged from the start, expecting the plant to grow on four sides if need be. Don't crowd your neighbors if you have room or space elsewhere. Don't imagine that your kilns full of burned brick is the end of the yard, or the last of the bricks. Have room enough beyond the end of the kilns to unload any excess of orders during the dull seasons, and then when the rush comes you can take advantage of the opportunity and draw on the stock pile to fill urgent orders. If you are stocked up in your kilns with no room to unload, you would be obliged to stop the works and wait for orders to empty the kilns; and your stock of brick could never exceed the capacity of your kilns. It is all very proper to make your works compact, but don't get too close to the "other party." Let it be understood first, last and all the time that brickmaking is a trade; a calling; brick burning an art, a profession if you please; or as much so as the architect is to being an artist.

Brickmaking and burning is a trade that cannot be learned in a week or fortnights' travel among the brick yards; or mere reading a fine description of other brickmakers' success; or listening to fine spun theories, based on the failures of the unsuccessful brick man. A great many brickmakers have been obliged to dismount from a theoretical hobby.

The brick business must always remain a business by itself, and there is not much that can be used with it or in connection with any other manufacture. We speak of this here, as we have found some parties who have been raised in some other occupation and followed it nearly all of their active lives, and are now interested in a brick plant as part owner or probably manager or superintendent of the same. In most cases their former success was due to a thorough knowledge of one particular line of trade. The great mistake that is likely to occur here is, they presume too much on their knowledge of their former business and carry certain methods over from one calling to the other. We have in mind now parties who were connected with the dry goods trade, railroad work, saloon keeping, lumber yard, cotton buying, etc., and many other occupations that had proven profitable to them.

The saloon keeper, managing a brick yard according to the theories of some of these men would require the off-bearer to wear a Tam O'Shanter cap and a white apron, and be provided with a clean towel to wipe the trucks off with, like unto a saloon counter; and have the whole place scrubbed out every morning before daylight.

The railroader will sit down and figure it out to have all brick trucks and barrows moved about the yard from machine to dryer, and from dryer to kiln, like a baggage truck loaded with trunks, and they together with the clay cars and carts, must come and go on schedule time, and the green trucker with No. 1 barrow must side track at the corner for No. 2 or 3 to pass.

Again the cotton buyer has an old compress that has gone through the fire when the ware house burned, and he has been struck with an idea *that hurt him some.* The compress will answer for a brick machine with a little rebuilding and he has been experimenting for the last three years on it, while his competitor who has had more sense and less cash, has pushed ahead with a laugh at the folly, and has made bricks and some money.

To parties who are just beginning the business and have no knowledge of the best methods of making and burning brick, we would advise them to get such knowledge as lay nearest them first. "Don't" be afraid to ask questions of those who do know, nor imagine that you will get all the advice and assistance you want without money and without price. Show yourself willing to pay for advice here, as you do your doctor or lawyer.

We believe it would be a good plan for all new firms just starting, to set aside a certain amount of their working capital, as a fund to cover traveling expenses, and about once or twice each year send a member of the firm, together with the manager or foreman to those yards that are making the best bricks, and are accessible, or they are competitors in the same market; and go expecting to find something better in the way of making, drying or burning which will pay you to adopt. Your foreman who is, or should be, a practical brickmaker will pick up a vast amount more of brick lore than you will, and come back recruited and replenished and ready for work. He will make more of an effort to please you and think more of you in every way. In case you make such a trip, look well to all the details; take note of all you find that is worth anything to you, and also note well the defects. Don't allow the proprietors to hurry you through the yard with a "Now you see it," and then out of the works with a "Now you don't see it" manner. Go quietly, moderately, and without demonstration, or display; take time enough to talk to

those who can and will give you such information as you desire or need. Then when you can, *return the favor*, in kind at least, Don't be a "sponge," a "chronic" or crank. Give in return for what you get.

We used to have a teamster that drove a fine span of mules, which he had trained to move at the word, and pull as they should at the right time. His word to the team when he had a load a little above the ordinary, or any hard pull was "Get right now," and the mules would lean forward on the collars, and at the next word they would walk off with the load. It seems to me that, to-day, as an Association of Brickmakers, we can do no better by the inexperienced, who contemplate starting or who have but recently started, than say to them as Joe said to the mules "Get right now," for it will be a hard pull. What we *have* said and *shall* say here is meant for the inexperienced or new firms. It is supposed that the brickmakers who have been long in the business are *experienced*, and are not in need of *hints*. We do not expect they will tear up their yards, or pull down buildings to rebuild them, but so far as they can, consistently, in adding to their works, so modify them as to suit the requirements of the trade, with the advanced methods in use.

In starting your building for brick works, bill all your lumber at once and order it in one lot in bulk, rather than a car or two at a time, there will be less vexation on account of delays and shipment. Pile your lumber in neat piles as you unload. Keep each size and kind separate from the other; procure all the material needed to push the work without waiting for anything. Build your engine and machine room first; and the best plan in setting up your heavy machinery is to put in the boiler and engine first. It takes more time to set up and properly adjust this part of the plant than any other. Make all steam and water connections and fuel supply secure before you start; neglect no part of this

work, everything is important here; this is the head or power of the whole plant.

I have noticed that a firm of new brickmakers, or a new firm of brickmakers are always certain to order their brick machine first, and they keep it around outside in the way and in the weather for six weeks, or two months or more. Begin with the engine and boiler as a nucleus from which to work out and away from it. Get an engine too large, rather than too small. The small one will have to be substituted for a larger, and that makes expense and delay. "Get right" on this.

Get a first class engineer; one who understands his business in caring for and running an engine. Very often a man can be hired who is fully competent to run your engine, and is a machinist who can do a great many repair jobs on a machine, engine, shafting, pulleys, etc., and who can also do all the smith work about the works if he is provided with a forge and its equipments. If you are so fortunate as to get such an engineer, supply him with a good fireman who can control the engine and keep up steam, and let the engineer be in charge of all the machinery. Furnish him with a set of dies to make any ordinary sized bolt and also a set of tools to cut and fit steam and water pipes up to two or three inches in size, and then a small stock of pipe and pipe fittings, and a few bars of flat and round iron and steel, a vise. bellows and anvil; then if he is the mechanic you need, he will fashion the necessary tools for his work out of the stock. In this way you will save many repair bills, and cut expenses at an important point. Make your buildings high enough to have the shafting, pulleys, belts, and all gearing that goes overhead well up out of the way. I find more engine and machine rooms too low, than too high. Ten feet is too low for side walls, twelve feet is low enough, thirteen or fourteen feet is better. When the eaves are low down they are in the way and cars of clay cannot be brought in under

the eaves inside the building. Then your machine has to be set low down below grade, to get room to feed it, while your clay supply is left near the outside of the building. You have no room for storage of clay surplus, and a summer shower will stop the works for want of clay supply. When buildings are low down, beams and braces are in the way, or if taken out, your building is weakened to that extent. I cannot understand why some men build their sheds and all their buildings on the brickyard so low down when it requires only six inches or a foot added to the length of a post, to have them high enough to save the heads of the workmen, and keep the proprietor upright. I have an acquaintance with several yards where the proprietor goes about among his buildings all day in a hump backed position to keep his head from contact with the beams above him. Of a necessity much work has to be done on a brick yard at night; and when beams and braces and doors are all low down, it is certainly a very uncomfortable place to work. Even in day time a workman with his head in danger works ill at ease, and cannot do his best; he watches his head as much as his work. The floors of machine room and dry floors under sheds are continually filling up and have to be graded off more frequently when the eaves are low.

Furnace sheds and kiln roofs, should be high enough to be safe from fire without removing. "Get right" on the height question. Get tools enough at the outset to start you off without a hitch or jar of any kind for want of tools to work with. We have seen proprietors start a yard expecting to make 50,000 or 100,000 bricks per day, who bought a half dozen trucks for green bricks, a half dozen barrows for dry bricks, four tray barrows, a dozen shovels, four picks and two mattocks; and protested for weeks and months against getting more, except when a pick, shovel, or barrow was broken so as to be of no further use. I say get tools. Get *more* than you want. I would far rather have too many picks, shovels,

barrows, etc., etc., than to have so few that when a hand needed one he was sent wandering around the yard for a half hour or more, over two or three acres of brickyard buildings, to hunt up an idle shovel or pick, or any other needed tool. Have a tool room. Keep it locked, and some responsible party in charge of it; it is a poor recommendation to any firm to have tools scattered all over the premises. Let each separate gang of workmen have a good tool box that can be locked up and the man in charge of the gang have the tools in his care.

Provide a large roomy repair shop; and then have all trucks, barrows, cars, carts, shovels, picks and all the paraphernalia that can be repaired, taken there immediately when broken and get a substitute; have extras for substitutes; don't delay your work waiting for a broken tool, but have one ready to go out, when the broken one comes in. Keep a man as a "Handy Andy" for repairer or any other work as needed. Let it be his job to look after all these things, and keep the buildings in repair or build new ones as needed. "Get right" on this point, by all means.

Supply yourself with machinery enough to keep up a steady stream of brick moving at all times without jar or stop. Then too, when you get your works built, and engine and machine in working order, and you have seen the machine make a few green bricks, don't expect to sell brick immediately; you can't do it. If you take orders, as we have known parties to do for immediate delivery, you will compromise your future credit in that way, by failure to fill orders. Customers are very easily affronted and your trade will soon go elsewhere. Worse still, an offer to furnish brick *all* hard, when you are not provided with kilns,or any knowledge of your burner, might result in a suit for damages against you, proving expensive, discouraging, and even disastrous to the firm. And right here is a temptation in the way that tends to hurt any new company; that is, the desire to sell bricks out of

the first lot made and burned, knowing full well they must needs use several hundred thousand before the works are any way near completed, and they ready to go on the market with bricks. This is frequently done to help keep up the running expenses of the works, and help the concern along by building up a trade, but rather retards the building operations in this, that it takes away from the plant brick that are needed to build kilns, dryers, walls, foundations, pavements, etc., and necessitates the drying of brick in the open air, and burning in old style kilns; trucking and wheeling brick and firing kilns on muddy, sodden floors, thereby suffering a loss of time, labor, fuel, and brick, and retards the growth of the works at its most critical period.

Acquaint yourself with the best brickmakers and their methods. If they are using old style ways, and that suits you better than any other, then suit yourself by all means. The public that buys brick will do the same, and if your neighbor or competitor makes better brick, they will choose between you and your neighbor. If he is using a patented dryer or patented kiln, don't condemn the patent business in a lump, but bear in mind that you are using a patented brick machine, run by a patented engine. Your belting, oilers, hangers, wrenches, etc., and even the buttons on the off-bearers overalls are patented. Don't question anything just because it is patented, but decide on its merits, by the work it will do. You may have seen the man who gets himself in a fever heat if you mention that the article is patented. You might with great propriety ask for a patent on his style of brick yard as its like is nowhere on the face of the earth.

Above all other things have a good, competent and reliable man as superintendent, or manager of your works; a man with practical experience, and business tact; one who can command the respect of both employer and employees. Get him and then make his situation so agreeable that it will pay him to stay, and you

to keep him. You will find enough men willing to serve in his stead at lower wages, but it will be better, for you if he has gotten things to running smooth, and seems to have but little to do, to bear in mind that if you change for a new and untried man with no qualifications for the place, that you and the new man both will be kept very busy for a long time to come. How often it is the case, that after a few months of well directed effort, and close management on the part of the manager, some member of the company who is a novice in brickmaking in all its details, is constrained to believe that the superintendent is an unnecessary adjunct to a brick yard; and that they in particular have no need of a man of that kind,the hands they employ can get along, apparently to them, without him.

The matter is talked over and worked up until as a sort of trial to see how it will operate, the superintendent is dismissed, and his salary is saved. But at what cost to the company! The ruin of one kiln of bricks, which almost always quickly follows, would have paid the salary for one or more years to come. And then comes not only one kiln but several follow in quick succession, or partially so. Trade is lost that is hard to regain. Confidence is hard to restore in the ability of the company to furnish their advertised goods promptly, and of a decided good quality, and for a time ruin is imminent. *"Get right" on that.*

INDEX.

THE CHICAGO IRON-CLAD DRYER.

FOR ALL KINDS OF BRICK AND TILE.

This Dryer is in no sense an experiment, but is an acknowledged and fully demonstrated success.

The Purington Paving Brick Co. who have one of the largest and best equipped brick works in America, have an **Iron-Clad Dryer** forty-two feet wide and one hundred feet long in which they are drying paving brick in twenty-four hours.

THE SECRET OF SUCCESS.

Good, experienced brickmakers differ honestly as to the best machinery and most economical methods of making brick, but all agree that brick are better and more easily burned if thoroughly and equally dried before being placed in the kiln. How best to accomplish this is a question that every brickmaker should consider carefully. We believe that our system is both the most economical and effective now in use, and are prepared to fully demonstrate this by actual results rather than by mere assertion.

The Iron-Clad Dryer is now in successful operation in nearly every State in the Union. We court investigation and will cheerfully give any information desired relative to the cost of construction and operation. **Dryers of any desired capacity erected under positive guarantee.** We manufacture our own trucks, cars, turn-tables, etc.

IRON-CLAD DRYER CO.,

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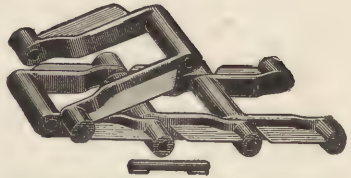

Mey Detachable Chain Belt, Pat. Feb. 7, 1888.

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. . . APPROVED APPLIANCES FOR . . .

Elevating, Conveying & Transmission of Power

64 to 68 Columbia St., BUFFALO, N. Y.

THIS Elevator is for taking the clay into the brick machine; the tempered clay is shoveled from the soak pit into the trough from which it is elevated into the brick machine. The advantages derived from this apparatus will be noticed at a glance by every practical brickmaker.

Mey Patent Clay Elevator.

It gives the machine a uniform feed, takes less power and manual labor to manipulate, and the manufacturer is enabled to

Make Many More Thousands

of the best quality of brick in a day than he can by the old method thereby saving time and making money.

Send for catalogue.

F. H. C. MEY'S

PATENT

CLAY ELEVATOR AND CONVEYOR

FOR

ELEVATING AND CONVEYING SOAKED SOFT CLAY INTO THE BRICK MACHINE.

Practical brick mannufacturers will see its good points at once. It dispenses with the old method of shoveling or wheeling the soaked soft clay from the pit into the brick machine. The Elevator and Conveyor can be set at any convenient place, and pits are dug into the ground on one or both sides. This does away with building a raised platform or pit back of the brick machine, thereby saving more than the cost of this Chain Elevator and Conveyor, and being on level ground it is far less hard work for horses filling the pits and enables them, at the same time, to draw heavier loads. If there are pits on each side of the Elevator and Conveyor, this will enable the operator to run the brick machine every day. It will elevate the clay as fast as wanted and requires but little power. The pit men can handle more clay by using this Elevator and Conveyor and do their work with less labor than by the old way of getting the clay from the soak pit into the machine. Different kinds of clay can be mixed thoroughly by putting light clay in one part of the pit and strong clay in another, and when there are two pit men, one can handle the light and the other the strong clay, and both kinds being elevated to the brick machine at the same time, it will be thoroughly mixed in the machine.

Elevators and Conveyors for elevating or conveying dry clay from the bank or shed to machine can also be furnished.

F. H. C. MEY,

BUFFALO, N. Y.

No. 10 or letter B
Brick Machine.

FREY-SHECKLER CO., Bucyrus, Ohio.

MANUFACTURERS.

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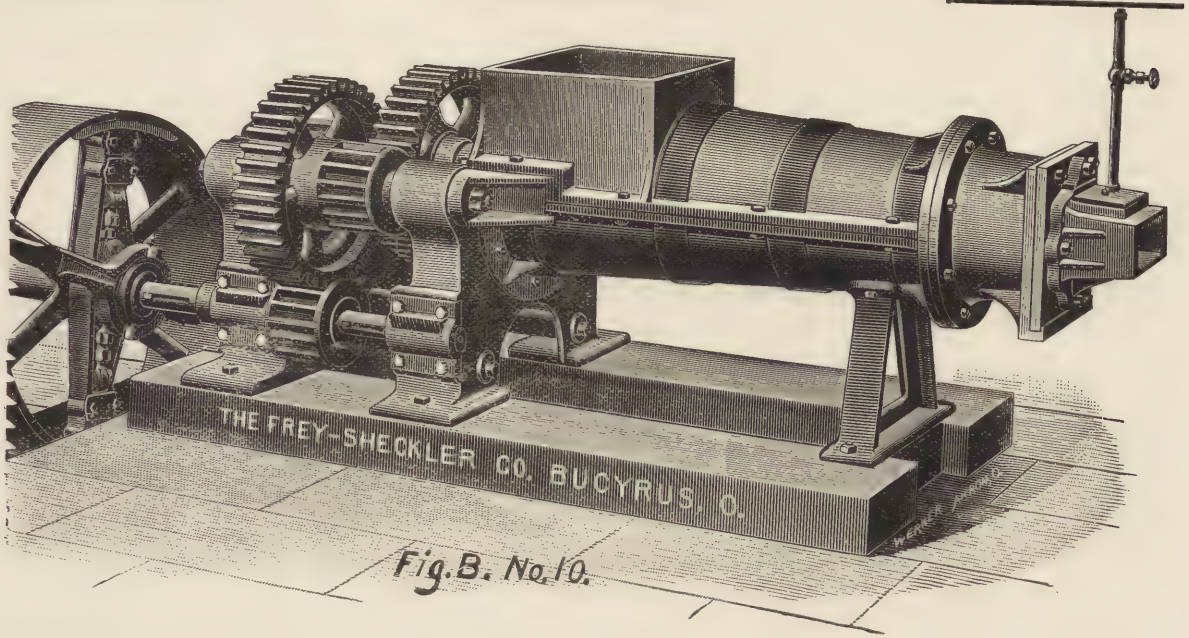

Fig. B. No. 10.

THE FREY-SHECKLER CO.,

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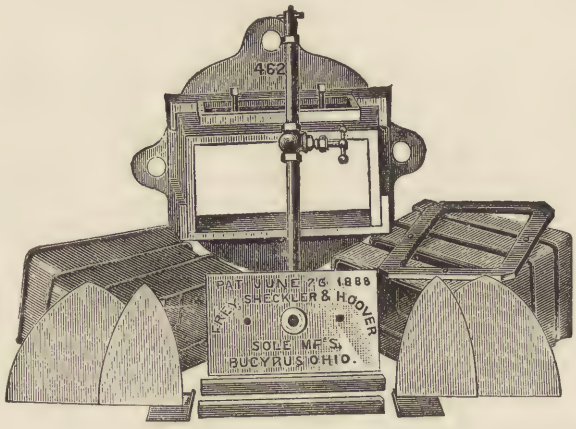
——MANUFACTURERS OF——

CLAY WORKING MACHINERY,

Full Factory Outfits.



Eight Different Brick Machines Using the Celebrated Neidergesaes Patent Lubricating Brick Die.

Perfect lubrication, sharp corners, solid body of brick.

Size of brick never changes by size of Die.

The Die does not wear out, as the steel liners take up all the wear and are cheaply replaced.

Can be used for any shaped Die.

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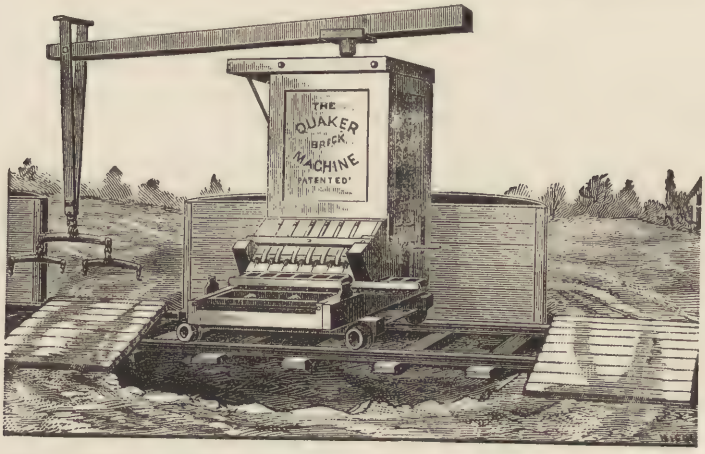
BUCYRUS OHIO.

IMPROVED BRICKMAKING MACHINERY

The "New Quaker"

The most Simple in Construction, Most Powerfully Built, yet the most reasonable in price of any first-class Brick Machine in this Country. Over 1,000 are in operation, scattered throughout every State in the Union, giving the most perfect satisfaction.



New Quaker Horse Power, Capacity 15,000 to 20,000.

The above cut represents the Horse Power Machine and pits ready for work.

Regular Steam Power Machine, capacity 20,000 to 25,000 per day. Extra Heavy Steam Power Machine, capacity 30,000 to 50,000 per day.

We make a specialty of equipping complete yards, including Engines, Boilers, Pug Mills, Mold Sanding Machines, Molds, Trucks, Barrows, Shafting, Pulleys, Belting, Etc., Etc., all set up and in running order. Send for Illustrated Catalogue.

Correspondence solicited.

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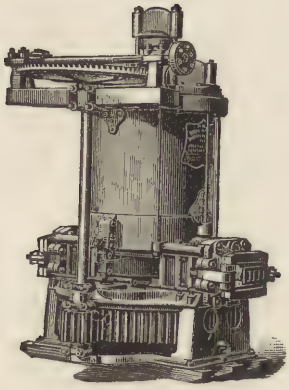

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MANUFACTURERS OF

CLAYWORKING MACHINERY

OF ALL KINDS.

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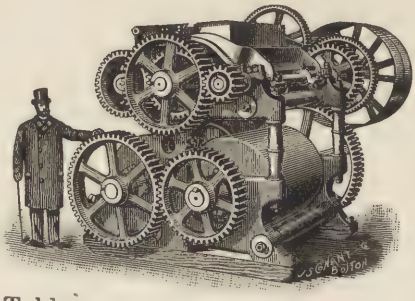
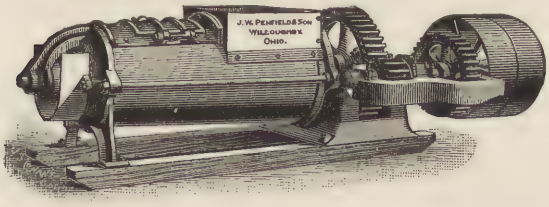


Transfer Cars and Turn Tables;
Winding Drums and Clay Cars;
Line Shafting, Pulleys and Hangers;
Kiln Castings and Yard Supplies.



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THE "NEW HAVEN"

Horizontal Brick Machine.

Weight, 14,000 Pounds.

Is the **Heaviest, Most Powerful** and **Best** Machine built in America for making sand moulded brick, being carefully designed to secure the **greatest possible production of first-class brick with the least outlay and loss of time for repairs.**

This machine meets the demand from brickmakers who think it wiser to buy a **high grade, substantial machine** than to waste time exhaust patience and lose money with light and cheaply constructed machines that are manifestly unequal to the many enormous strains and heavy duty required of clayworking machines.

It has made a record of which we are decidedly proud.

We invite correspondence and inquiry.

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Are the most powerful and rapid working machines for repressing **red and fire brick, paving and furnace blocks, roofing and flooring tiles, etc.,** upon the market.

Without an Equal
FOR
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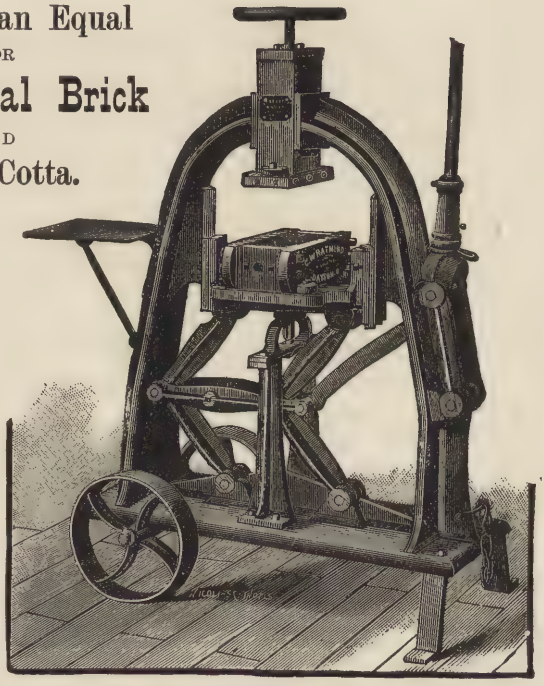

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Investigate our Machinery and You will find:

- Rapidity.
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We make a specialty of furnishing the very best of all kinds of supplies, and the superior lasting qualities of our molds, trucks, barrows, etc., etc., has made us many steady customers, after once giving us a trial order. Full outfits a specialty.

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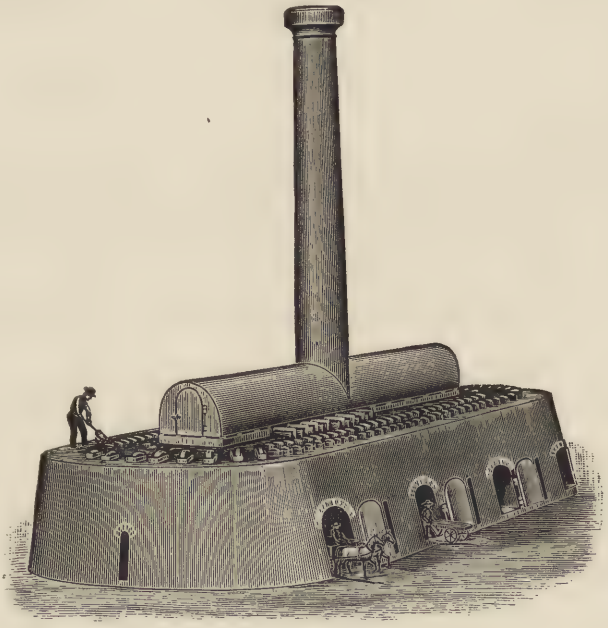
BRICK KILN.

Experienced brickmakers readily concede that the most important factor in brickmaking is the *burning*. On nothing does success depend so much as the economical and thorough burning of the brick.



This kiln is adapted to the burning of all kinds of material made of clay and is especially valuable where intense heat is needed. Any kind of fuel can be used. No interference from rain, frost or cold. Runs the year round. For saving of fuel, labor, time and money it is unexcelled.

For plans and specifications, cost of construction or any other information, write

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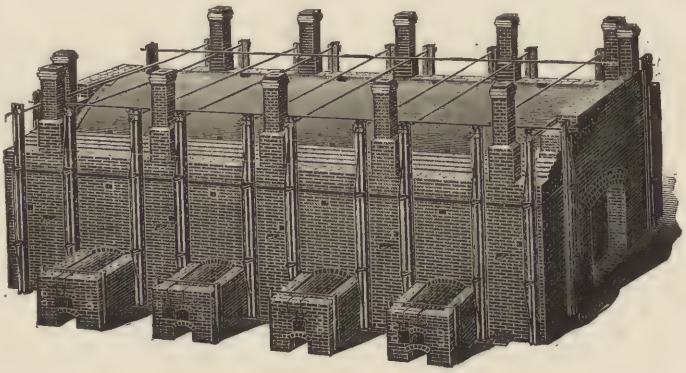
THE EUDALY KILN.

No Longer an Experiment.



This is a Down-draft Kiln, built either round or square and of any desired size.

These kilns are better adapted to a large output than any other kilh in use where all hard brick is desired.

This Kiln is peculiar in this:

The CONSTRUCTION is such that the heat can be driven to any part of the Kiln at will.

While this is a DOWN-DRAFT KILN, a PART of the HEAT can be TAKEN to the wares in the BOTTOM DIRECT when desired.

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